THE Petroleum Engineer

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THE ENGINEERING MAGAZINE OF THE OIL AND GAS INDUSTRY

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Meetings

World Petroleum Congress —Imperial College of Science and Technology, South Kensington, London, England, July 19 to 25.

•

Society of Automotive Engineers — Chicago, August 23 to September 4.

•

American Chemical Society —Stevens Hotel, Chicago, September 10 to 15.

•

American Gas Association— International Gas Conference and Annual Meeting, Stevens Hotel, Chicago, September 25 to 30.

•

A.I.M.E. Petroleum Division —Mid-Continent Section, Baker Hotel, Dallas, October 6 to 7. Western Section, Los Angeles, October 6 to 7.

•

American Petroleum Institute—Annual Meeting, Stevens Hotel, Chicago, October 24 to 26.

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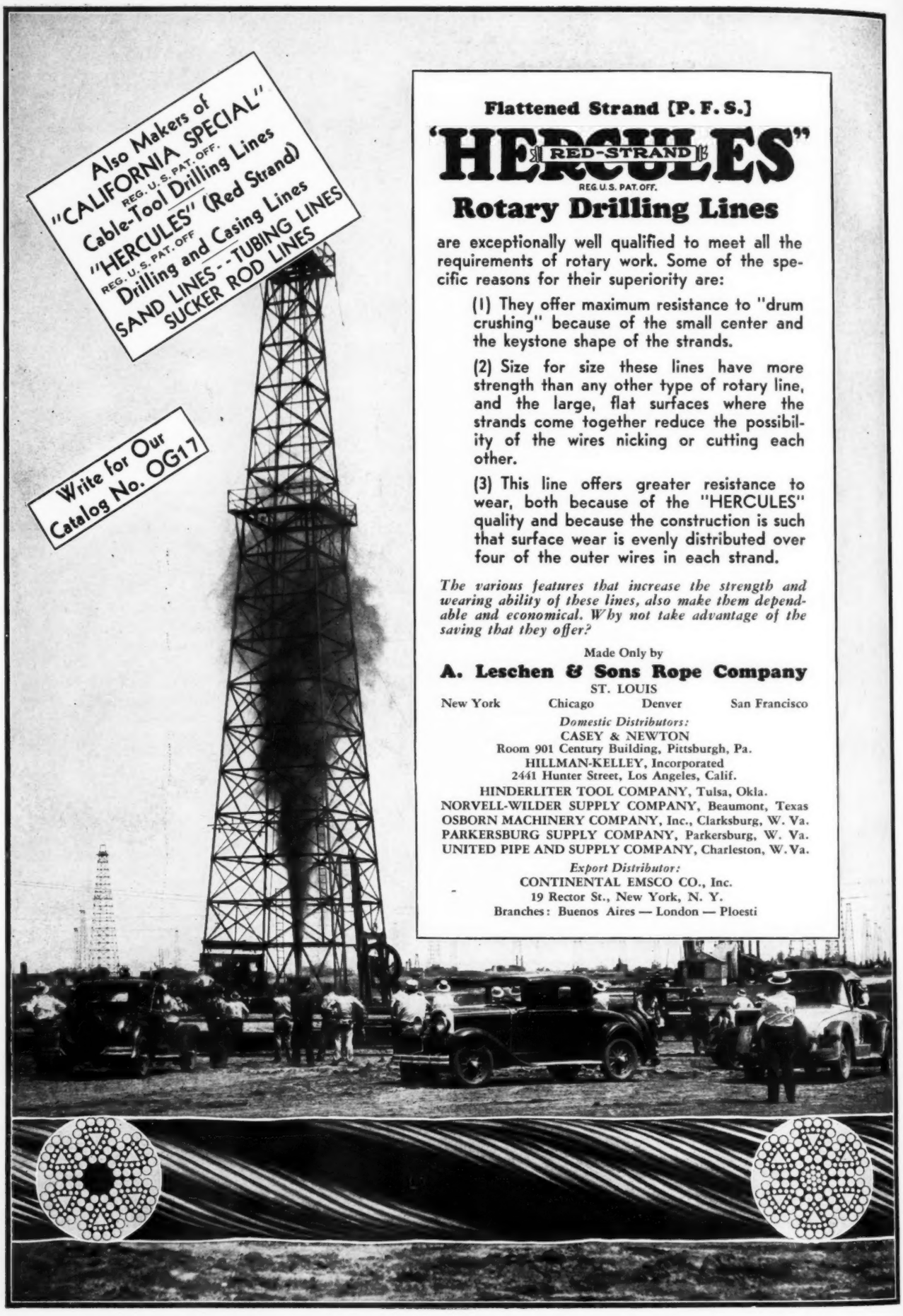

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The Course of Oil

By K. C. SCLATER

Co-operative Development and the Code

HAVING drawn up a code of fair practices under which it would conduct its business to conform with the broad purposes of the National Industrial Recovery Act, the oil industry of the United States now awaits action from Washington. If approved, the code will have a far-reaching effect on the future policies of the oil industry and will be felt by large and small producer alike. As now written the code provides protection to the 300,000 wells that produce only a few barrels or less of oil daily. After a new field has been discovered further drilling will be illegal until a plan of development has been agreed on for that field and a permit granted by the Federal Administrator for the drilling of subsequent wells. It will be lawful to restrict production by agreement in order that it be held within the required limit, and producing oil in excess of this amount will be construed as unfair competition. These three provisions alone, in one step, place the producing branch of the oil industry on the threshold of co-operative development of oil pools and wipe out many of the legal restrictions that have hampered progress in the past. Thus what might have taken years to accomplish, if ever, may be brought about overnight by a national industrial emergency.

In an address before a group of business executives outlining the policy to be followed in carrying out the provisions of the recovery act, General Johnson said, "You have a great many difficulties that by agreement among yourselves you could cut out and you could achieve stabilization of industry. The function of this administration is not to reach out and control your industry but for you to come to this table and offer your ideas as to what you can do to clear up the difficulties of your industry. From an economic standpoint, I think we have learned enough since 1928 to know that one of the difficulties of our country is that created by production far in advance of our power to consume. . . . This administration will attempt to guide and make suggestions to those industries forming codes. You think you could better your position by wiping out all that is destructive and harmful. . . . When the code is approved it becomes a sort of law merchant for your industry. . . ." These statements, although intended to apply to business in general, are particularly apt and come near to covering the case for the petroleum industry. There is no mistaking the fact that conditions within the industry have vastly improved during the last month and this welcome change in outlook is in no small part due to the steps taken toward business recovery by the Federal Government. Industrial rehabilitation plans in the United States may prove to be the salvation of the oil industry.

Significant Pipe Line Research Project

A COMMITTEE of the Petroleum Division of the American Society of Mechanical Engineers at Tulsa, in undertaking an investigation to derive and check basic formulae for the calculation of fluid flow through pipe lines, is embarking on a task that will have the support of engineers and others interested in this subject. The significance that attaches to this project is the thorough, practical and comprehensive manner in which the tests will be conducted. Not one but ten separate pipe line systems will be used in the tests and the data resulting therefrom studied and checked in reaching conclusions. Only data incident to the handling of crude oil will be considered in this investigation, which will take six months to complete. It is hoped to throw some light on the problem of paraffin deposition in pipe lines by investigating the effect of changes in the velocity of flow, then comparing the possible removal or prevention of paraffin by this means with that of the mechanical scraper. Co-operative research projects of this kind wherein the combined resources and knowledge of companies and engineering talent are brought together cannot but be productive of the greatest good and will achieve results in six months time that otherwise might have taken years.

●

The Stimulus of Water-Flooding

THOSE who are accustomed to thinking of future reserves of oil in terms of large flush fields that have a spectacular beginning, may be surprised to learn of oil reserves in fields that have a remarkable past. The Eastern fields of the United States have been producing oil continuously since 1859, the year the Drake well was brought in. Far from being exhausted or being laid low by the infirmities of old age common to oil fields, these fields, which are the cradle of the oil industry, still have a future that many producing areas in the country much younger can never hope to achieve. It is estimated that they have an oil reserve of 1,020,000,000 barrels still to be recovered. A large proportion of this reserve of crude petroleum, be it noted, is in the Bradford field, where water-flooding as a method of production predominates. This secondary method of recovery, by greatly augmenting the ultimate recovery, has been a large factor in prolonging the life of these fields. What has been accomplished in the Bradford field under the stimulus of water-flooding might well be emulated in other fields.

« « « HIGHLIGHTS IN OILDOM » » »

Crude Oil Prices Increased

A group of Mid-Continent crude oil purchasing companies followed the leadership of Continental Oil Company and Sinclair-Prairie Oil Marketing Company, in adopting a 33-cent increase in crude oil prices, effective July 6. An increase of the same amount was made effective in the Mid-Western States by Ohio Oil Company.

But other Mid-Continent crude oil purchasers did not agree with the prices established by the above group, consequently, as this is written, there are in existence four different posted prices for Mid-Continent crude. All groups have important crude buyers in their ranks. One of the additional postings is a 23-cent rise, another group is made up of companies advocating a 10-cent increase, and there are purchasing concerns that have not changed their schedules from the old rate. Later the Continental Oil Company reduced its schedule to that of the group favoring a 23-cent increase with a top price of 75 cents and indications are that other companies will compromise and also adopt this schedule.

●

Industrial Code Meeting Obstacles

Although the code of "fair competition" drawn up last month by a number of delegates from various oil industry associations when in conference in Chicago has been favorably passed upon by a number of the associations represented, it has encountered several obstacles. The National Recovery Administrator has rejected it for failure to deal with wages and working hours. Before it meets with general favor from all factions comprising the petroleum industry there are several problems to be worked out. Several classes of operators have clauses they wish to have incorporated into the code.

Despite these obstacles much progress has been made and the fundamental principles stipulated by the tentative code are generally favored by industrial leaders. Before the series of conferences are over an adaptable code of operation may be worked out that will be beneficial to the industry and suitable to all classes of operators. These differences in opinion will be threshed out in a conference to be called soon at Washington, D. C.

●

Texas Independent Refiners Organize

The Texas Independent Refiners' Association has been organized for the purpose of forming a code under which independent refiners will operate. The first step taken by the association was the drawing up of a code designed to adopt provisions of the National Industrial Recovery Act. The new code, which is of importance because it is primarily a refiners' document instead of a marketing agreement, provides for reduction of withdrawals from stocks from allowable of those withdrawing, and deduction of imports from allowable of those importing, except under bond, for processing and re-exportation. The code also calls on President Roosevelt to enforce the pipe line divorcement clause of the National Recovery Act.

●

East Texas Back Allowable Discontinued

During the month of July, the Texas Railroad Commission has discontinued permission of operators to make up unproduced allowables in the East Texas field. Back allowable is figured at the rate of 25 bbl. per day to compensate the well owners for the period after completion when a well has no market outlet.

This move is an attempt of the Commission to reduce illegal production of crude oil in the field. Under this order East Texas was expected to produce not more than 550,000 bbl. net allowable every 24 hours, except for the amount run out of storage. Since establishment of this order production has exceeded the legal amount by smaller margins, but it has not been fully successful in bringing the output down to the desired figure. Overproduction the first week of the back allowable moratorium averaged 150,000 bbl. per day.

●

Greta Field Development Orders are Issued

In the new Greta field of Refugio County, South Texas, wells will be spaced in the center of 20-acre units under provisions of a new operating order issued by the Texas Railroad Commission. In drafting its order for this field the plan in use at Conroe was followed, including complete rules for the drilling and completion of wells. The Greta field was only recently discovered and the Commission has taken these steps to prevent a repetition of an East Texas situation.

●

State Files Many Cases Against Violators

That the State of Texas is in earnest in attempting to enforce proration laws in East Texas is shown by the filing of 172 cases against alleged violators in the field. Of this number 144 have sought injunctions for overproduction and violation of the Commission's orders. Twenty-nine receivership applications have been filed. There have been 19 contempt charges of violations of injunction orders of the courts, on which two persons were convicted and served sentences. There have been 19 dismissal cases, where agreements have been reached between the defendants and members of the Attorney General's staff. Several receivership cases have been tried and in all but one receivers were appointed. This concentrated drive by the State's legal department is helping to reduce illegal production of oil in East Texas.

●

Conroe Allowable Increased

Effective 7 a. m., July 7, the Texas Railroad Commision issued an order setting the allowable daily production of the Conroe, Montgomery County, Texas, field at 72,685 bbl., an increase over the previous allowable of 60,000 bbl. daily.

●

Alcohol-Gasoline Mixture is Inefficient

Adding alcohol to gasoline spoils both products, according to the results obtained from road tests made by the American Automobile Association. A mixture of 90 per cent gasoline and 10 per cent alcohol was found to produce a motor fuel that was 4.94 per cent less efficient than regular gasoline, without regard to the fact that the mixture is more expensive than straight gasoline.

●

Law Enforcement Council Organized

The Texas Petroleum Council has been formed by a group of more than 150 Texas oil operators for the purpose of assisting the State enforcement agencies in enforcing proration orders issued by the Texas Railroad Commission. This is the first organization of the kind to be formed by oil companies. The members have gone on record as believing that "hot oil" is the source of most troubles in the industry today, therefore they plan to speed up the case in court at Fort Worth, testing the validity of the East Texas order. The Council is made up of a cross-section of the petroleum industry from small independents to major company executives.

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LATEST ACTIVITIES IN THE OIL FIELDS

THE most important development in the petroleum industry during the past month from the standpoint of new production was the extension of the Tomball pool, northern Harris County, Texas, Gulf Coast. The field was projected two miles north by the completion of Magnolia Petroleum Company's Rudel 1, which is making 50,000,000 cu. ft. of dry gas with a tubing pressure of 1900 pounds. It is believed that the volume and pressure of the gas are so great that oil is unable to enter the hole. The company may decide to case off part of the upper sand and drill deeper into the Cockfield formation.

•

This important well is the second producer in the new Tomball field, opened a month ago, and definitely proves that the new producing area is as great a market factor as has been predicted for it. A north and south length of 11,500 ft. at Tomball is proved productive by this test. There are many drilling obligations in the new field and a lively exploration campaign is in prospect. It is fortunate, apparently, that the Railroad Commission has seen fit to restrict drilling locations to one per 20 acres, and unless the field is extended to the east, where numerous small tracts exist, there should not be much difficulty in establishing an equitable proration schedule.

•

A series of wildcat strikes along the Balcones fault, and in the Government Wells trend, together with additional pipe line outlets in new fields, have attracted additional drilling activity to South Texas. The most recent developments in a long series of successful wildcat completions includes the opening of new pools in northern Starr County, Bastrop and Zapata Counties and another in Duval County. Recent showings indicate that the new Greta pool of Refugio County is a large structure. At this time a well three and one-half miles from the discovery well is shut down while cement is allowed to harden. It is on top of a saturated sand at 3600 ft., which compares with a producing depth of 4386-4403 ft., in the discovery well.

•

Because of the success of operators in finding good crude oil production at comparative shallow depths in South Texas, this area has become the most active region in the Nation. Latest figures reveal the information that there are 26 rigs and 143 drilling tests, a total of 169 operations in South Texas. There are single pools in other areas of the state that are more active than any field in South Texas, but, taken as a whole, the region outranks all others.

•

With the exception of Texas, all states are experiencing a decided lull in drilling operations. This condition is not expected to continue, however, as there are indications that Oklahoma, California, Kansas and Louisiana will shortly show a marked increase in the number of tests carried on the active drilling reports. None of these states has any new pools that are being extensively developed, but some interesting news may be forthcoming as a result of the increasing wildcat play.

AVERAGE CRUDE OIL PRICES

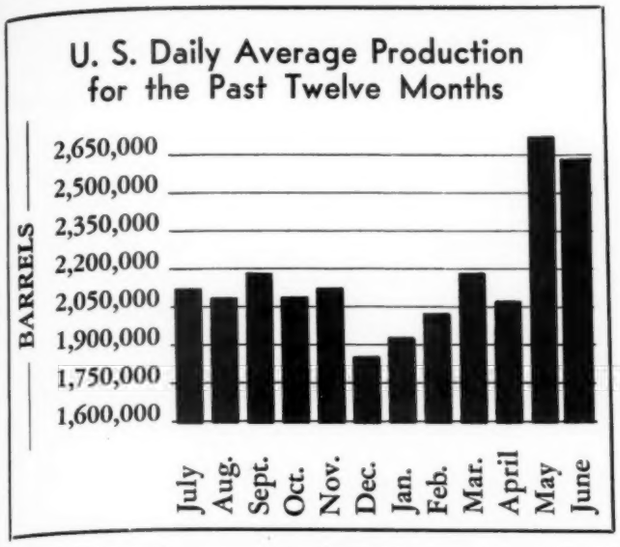
California		Arkansas	.50
Playa Del Rey	$ .76	Louisiana	
Coalinga	.52	North Louisiana	.77
Long Beach	.85	Gulf Coast	.54
Montana	.80	Illinois	1.00
Wyoming	.44	Kentucky	.95
Colorado	.44	Indiana	.45
New Mexico	.20	Ohio	
Texas		Lina	1.05
North Central	.77	Wooster	.70
Panhandle	.55	Michigan	.75
West Texas	.30	Pennsylvania	
Gulf Coast	.54	Bradford	1.57
Darst Creek	.40	Corning	.70
East Texas	.75	West Virginia	1.22
Kansas	.77	Canada	1.75
Oklahoma	.77		

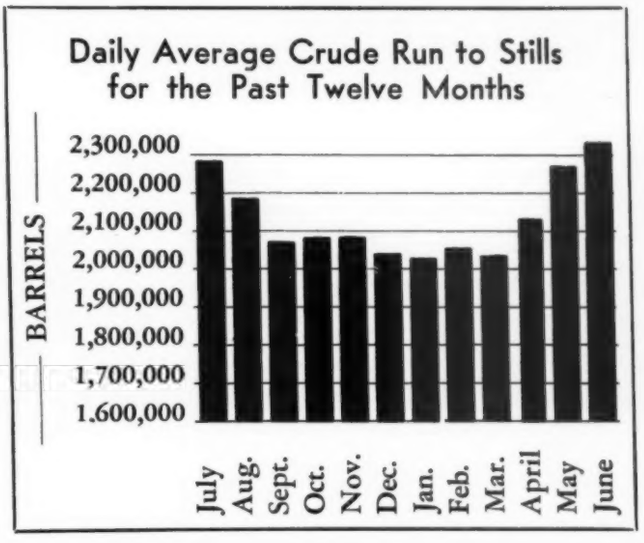
DAILY AVERAGE PRODUCTION[1]

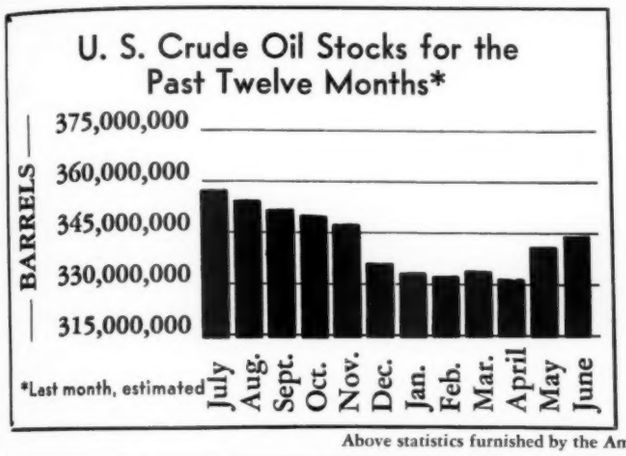
(Figures in Barrels)

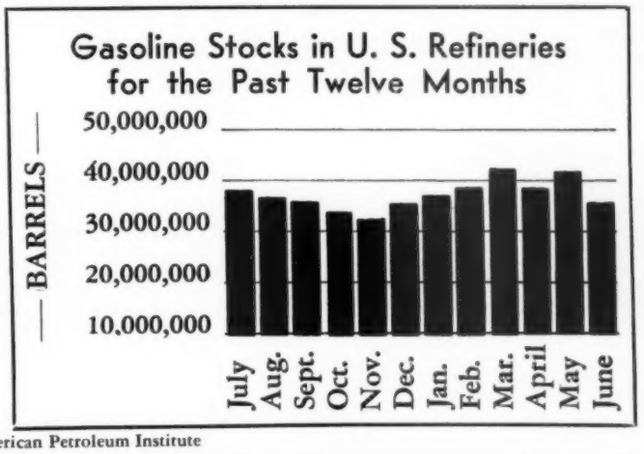
	Week Ended June 24 1933	Week Ended May 27 1933	Week Ended June 25 1932
Oklahoma	530,650	383,350	426,900
Kansas	110,400	105,650	98,300
Panhandle Texas	42,900	44,150	55,850
North Texas	47,050	47,850	50,400
West Central Texas	19,250	19,800	24,400
West Texas	156,900	160,500	178,950
East Central Texas	58,600	58,350	57,350
East Texas	565,250	814,500	331,800
Conroe	60,250	78,000	150
Southwest Texas	50,850	48,500	56,000
North Louisiana	24,500	26,400	29,850
Arkansas	30,300	29,950	34,000
Coastal Texas (Not including Conroe)	116,000	115,000	116,300
Coastal Louisiana	40,500	41,450	31,900
Eastern (Not including Mich.)	88 200	89,050	104,650
Michigan	15,200	16,100	17,650
Wyoming	29,250	27,400	35,000
Montana	6,650	5,900	7,200
Colorado	2,400	2,550	2,950
New Mexico	36,000	36,100	36,100
California	482,500	484,000	460,400
TOTAL	2,513,600	2,634,550	2,156,100

[1]Production figures furnished by the American Petroleum Institute.









Above statistics furnished by the American Petroleum Institute

Summarized Operations in Active Fields for June, 1933

Fields	Completions	Producers	Locations	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
Texas									
East Texas	84	83	116	37	46	3600	2	40	Rotary
Duval County	13	8	21	5	19	2300	2	22	Rotary
Conroe	45	45	32	3	39	5200	2	38	Rotary
Oklahoma									
Oklahoma City	2	2	10	17	19	6500	3	39	Rotary
Kansas									
McPherson	6	4	6	8	36	2900-3400	2	38	Rot.-Cab.
Ellsworth Arch	6	5	11	4	27	3300	4	37	Cable
Harvey County	4	3	5	5	25	3450	2 or 4	37	Rot.-Cab.
California									
Kettleman Hills	0	0	1	2	11	8300	3 or 4	40	Rotary
Long Beach	8	8	8	1	14	7000	3	26	Rotary

Field Activities by States for June, 1933

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1932 (In Barrels)
	June	May	June	May	June	May	June	May	June	May	
Arkansas	4	7	0	1	0	6	9	10	30	28	11,907,000
California	18	30	16	26	59	44	24	13	134	112	178,128,000
Colorado	1	1	1	0	....	....	5	7	57	56	1,177,000
Illinois	1	1	1	0	....	....	1	2	11	10	4,661,000
Indiana	16	7	9	6	....	....	1	2	57	51	804,000
Kansas	30	57	20	37	37	38	24	25	167	112	34,300,000
Kentucky	11	14	3	8	....	....	1	2	50	46	6,264,000
Louisiana	32	59	15	25	70	76	68	48	113	141	21,478,000
Michigan	7	28	6	22	24	29	46	43	73	74	6,729,000
Mississippi	6	6	2	2	....	....	0	2	14	14	Gas. Prod.
Montana	2	0	2	0	....	....	4	3	35	31	2,449,000
New Mexico	3	3	2	3	....	....	5	6	51	56	12,511,000
New York	4	2	4	2	....	....	10	2	19	12	3,501,000
Ohio	31	46	19	34	....	....	40	30	151	105	4,597,000
Oklahoma	68	102	44	65	72	91	75	69	264	216	152,621,000
Pennsylvania	14	47	13	41	....	302	13	28	48	85	12,403,000
Texas	313	456	218	299	455	....	145	143	637	551	311,069,000
West Virginia	18	21	12	12	....	....	20	9	43	28	4,472,000
Wyoming	4	2	3	0	....	....	10	9	57	57	13,359,000
Total	583	889	390	581	717	580	501	453	2011	1785	781,845,000

PROGRESS OF MAJOR PIPE LINE WORK

By WARREN L. BAKER

ALTHOUGH there have been no announcements during the past month of plans to construct large pipe line systems several projects, while involving no great expenditure of money, are providing much-needed outlets for new producing districts, making possible their early development.

●

The most important announcement from the standpoint of the amount of work it will require was that of the Michigan Natural Gas Corporation, which has petitioned the Michigan Public Utilities Commission for a permit to construct a 157-mile natural gas line from the fields of central Michigan to supply the towns of Saginaw, Bay City, Flint and Pontiac. The company was granted a permit several months ago to construct a gas main from the fields to Saginaw and Bay City, but now desires to extend its proposed system to include the other two towns. The system, which will include construction of a casing-head gasoline plant in the fields, will involve an expenditure of over $3,000,000. The line will be of graduated sizes from 8 in. to 20 in. in diameter.

●

Stanolind Pipe Line Company is going ahead with plans to lay a 31-mile oil line from the terminus of its present trunk system at Sinco, near Houston, Texas, to Texas City, where Pan-American Refining Company, a sister organization, is constructing a 25,000-bbl. refinery. It is expected that Stanolind's line will be of 50,000-bbl. capacity as the new refinery is likely to be doubled in size at a later date. Construction work on this line will probably commence in the near future.

●

Work on the Iraq Petroleum Company's 1200-mile pipe line across the deserts from the Kirkuk, Iraq, field to the Mediterranean sea is progressing at a rapid rate. Better weather is having much to do with the increased speed that the construction crews are making and it is likely that the entire project will be completed ahead of schedule. The 150-mile double line from Kirkuk to Haditha is completed and work is progressing both east and west on both the English and French lines from the sea to Haditha, with considerable work finished on the eastern end. Approximately three-fourths of the pipe has been strung and with continued good weather anticipated for several months, rapid progress is to be expected.

●

Sinclair-Prairie Pipe Line Company will complete its 140-mile, 12-in. line from Colonels Station, Mexia district, Texas, to Huffman station, near Houston, by August 1. Less than 15 miles of line remains to be welded on the project. The line, when completed, will provide the company a 12-in. carrier from the East Texas field to Sinco terminal on the Houston Ship Channel. This is the largest construction project under way in the United States. It involved the taking up of 140 miles of 12-in. line from Oklahoma City to Coffeyville, Kan., and relaying it in Texas.

●

Ford, Bacon & Davis, Inc., New York, contractors on the twin 60-mile, 6-in. gasoline line being laid from Toledo, Ohio, to Detroit, Mich., by the Pure Oil Company and Sun Oil Company, expect to finish work early in August. The line will terminate at Hamtramack, Mich., just outside of Detroit, where large storage and distributing facilities are being constructed.

●

A contract has been let to Winston Brothers of Minneapolis by the Santa Rita Oil & Gas Company for the construction of a 4-in. oil pipe line from the Cut Bank field, in Glacier County, Wyoming, to a railhead at Cut Bank. The line will be 15 miles in length and work is to start at once. Roy Tarrant, independent operator, is considering laying two lines from the Cut Bank field. One will be laid to a loading rack to be erected at Cut Bank and the other direct from the field to the refinery of Northwest Stellarene Company at Coutts, Alta., Canada.

●

There are many small pipe line projects under way in Texas. Magnolia Pipe Line Company's line from the Dale pool in Caldwell County, Texas, is being extended to the new Riddle pool in Bastrop County, a distance of four miles. Humble Pipe Line Company is starting work on 24 miles of 10-in. oil line from the Judkins area of Ector County to the Harrison-Addis pool, near Odessa, and thence to the Cowden-Holt pool in northern Ector County. Construction has been completed on the Moca Duval Pipe Line Company's 40-mile, 4-in. line from the Moca field, Webb County, to the Tex-Mex railroad. Both the Magnolia Pipe Line Company and the Humble Pipe Line Company expect soon to complete their short lines from the Tomball field, northern Harris County, to trunk lines.

●

In Louisiana the Shell Pipe Line Company is building an 18-mile line from the Iowa field, in Calcasieu Parish, to a point south of Lake Charles, La. Standard Pipe Line Company has secured right-of-way and started work on a 15-mile, 4-in. line from Pleasant Hill, La., to the Converse field of Sabine Parish.

THE MONTH'S ACTIVITIES IN REFINING

By F. R. STALEY

Per Cent Refining Capacity Operated

Eastern Division 76.0 Per Cent **Central Division 71.3 Per Cent** **Western Division 84.5 Per Cent**

ALCO PRODUCTS, Incorporated, a division of American Locomotive Company, of New York, has been awarded a contract by the Canfield Oil Company of Cleveland, Ohio, for the construction of a 1200-bbl. per day Pennsylvania crude distillation unit at the latter's Coraopolis, Pa., refinery. Of particular interest is the fact that the unit is designed to produce continuously and simultaneously an overhead gasoline and the following sidestreams: Solvent, kerosene, 300 distillate, gas oil, pressed or wax distillate and cylinder stock bottoms. Provision has been made for the future installation of additional sidestream for the production of heavy wax distillate. Also included in the contract was an additional unit for the production of light distillate specialties.

●

The Henry Vogt Company has been awarded a contract by the Phillips Petroleum Company for the installation of two large generating units for the Phillips Kansas City refinery. The units will be the largest ones of their kind installed in the Southwest in the past several years. The design of the boiler units embodies the very latest features. Each boiler unit, which is the Vogt Class LE Multiple Circuit Bent Tube design, will be capable of generating 50,000 lb. of steam per hour with a pressure at the outlet nozzle of 475 lb. per sq. in., and a superheated temperature of 150 deg. fahrenheit.

●

The Sloan & Zook Company is planning the construction of a 1500-bbl. vacuum still at its Bradford Pa., refinery. This company, large producers of Pennsylvania grade crude oil, recently took over a shutdown plant at Bradford and has organized a refinery division to recondition and operate the plant. The refinery has a present capacity of 1000 bbl. daily and is equipped for lubricating oils and wax. This output will be enlarged when the new unit is completed.

●

Associated Oil Company has completed test runs on the new cracking units recently constructed at the Avon and Watson, Calif., refineries and has placed both plants in commercial operation. Cost of these units was approximately $1,000,000. At the Avon refinery, in the San Francisco Bay region, the throughput has been increased 5000 bbl. daily. To handle this increased crude oil run it was necessary to increase the steam production and to double the size of the treating and rerun plants. The Watson plant, near Los Angeles, has been redesigned to subject the fuel oil bottoms, obtained from flashing off the light fractions of crude, to a viscosity breaking operation. The new furnace has a charging capacity of 7500 bbl. daily.

●

Several additional refineries in the East Texas field have commenced operation. Rusk Oil & Refining Company is operating its 2500-bbl. plant at Overton. The 750-bbl. skimming plant of Modern Refining Corporation at Gladewater has also started running crude. Ortiz Oil Company's 2500-bbl. refinery at Friars is now in operation and several new plants are under construction that will swell the total number of East Texas refineries to more than fifty.

●

The Oriental Refining Company and Taxman Refining Company have resumed operation of their Wichita Falls, Texas, plants, which have been shut down six and three months, respectively. The capacity of the Oriental plant is 2500 bbl. daily and that of the Taxman refinery is 3000 barrels.

●

Sinclair Refining Company (Consolidated Oil Corporation) has purchased a three per cent stock interest in the Great Lakes Pipe Line Company, which operates a gasoline line from Oklahoma through Kansas, the Middle West to Chicago. The Sinclair Company will use the line in the movement of gasoline from one or more of its Mid-Continent refineries. The Tulsa terminal is located only four miles from the company's plant at Sand Springs, Okla. The three per cent interest was obtained from the Barnsdall Oil Company.

●

Construction on Pan American Refining Company's new plant to be built at Texas City, Texas, will get under way immediately. Preliminary work is practically finished. Plans for the refinery call for the construction of a 2500-bbl. cracking unit by the M. W. Kellogg Company, a large boiler plant, a rerun still unit, a recovery distillation plant and a treating unit.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending May 27, 1933

A.P.I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbls.	Gas and Fuel Oil Stocks
East Coast	100.0	488,000	83.8	15,476	7,150
Appalachian	92.6	87,000	62.3	1,943	905
Ind., Ill., Ky.	97.3	348,000	81.9	7,464	4,004
Okla., Kans., Mo.	81.8	238,000	64.0	4,528	3,322
Inland Texas	58.3	90,000	56.8	1,394	2,248
Texas Gulf	98.0	430,000	86.4	6,157	6,487
Louisiana Gulf	100.0	116,000	87.9	1,456	2,051
No. Louisiana-Ark.	92.6	45,000	58.8	252	534
Rocky Mountain	72.1	45,000	77.3	1,141	717
California	96.9	475,000	57.8	13,506	98,640
Total June 24, 1933	92.0	2,362,000	72.4	53,317	126,058
Total June 17, 1933	92.0	2,344,000	71.8	53,579	125,468

Making Photoelectric

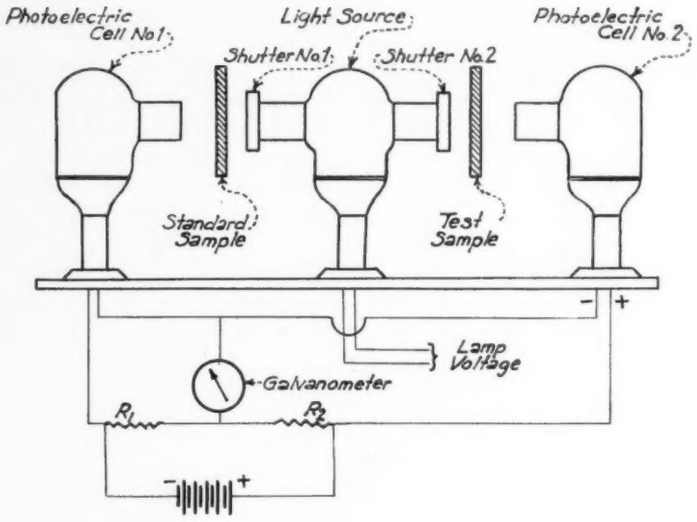


Fig. 1

THE variation in electrical response of photoelectric cells to differences in light intensity and to variations in the color of light makes possible the accurate measurement of such differences. There are, however, a number of considerations to be taken into account in the design of such equipment and it should be pointed out that neglect of some of these factors may result in very considerable sources of error. In general, it is desirable in making measurements of this kind to have a standard of comparison so that the actual measurement is that of the difference from the standard rather than an absolute value.

Inasmuch as it is necessary to use an artificial source of light, generally an incandescent lamp, precaution in the design must be taken to avoid error due to variations in the intensity of the light source. Because the candle power of an incandescent lamp varies considerably with rather small changes in the voltage applied to the lamp, it is almost impossible to maintain the lamp voltage sufficiently constant for the most accurate work. Even when storage batteries are used there will be a considerable difference in the lamp voltage when the storage battery is fully charged or when it is partially discharged. Inasmuch as storage batteries are rather inconvenient in many types of work because of the necessary maintenance and care required, a balanced circuit photometer — which is less critical with respect to the operating voltage of the lamp — is to be preferred.

The balanced photoelectric photometer arrangement, which is described herein, tends to reduce the errors due to slight variations of intensity of the light source. When a suitable standard of comparison is available, accurate and reproducible results may be obtained with this system. It is, of course, very much easier to obtain a comparison between samples of a transparent or translucent material of similar color than it is between samples of opaque materials, or of materials of unlike color. The reason is obvious in that with opaque materials the quantity of light available on the photoelectric cell is necessarily less than when the light is transmitted by the samples. Furthermore, in comparing materials of unlike color it is necessary that one be certain that it is only a difference in color that is being measured and not a combination of difference in color and a difference in transmission or in reflection. In other words, the photoelectric cell integrates the effect of changes of color and changes of light intensity and it is readily possible to obtain two identical readings with two samples of unlike color and of unlike transmission or reflection coefficients. A typical case might be one in which an opaque sample of highly reflecting blue material might produce the same response in the cell as a red sample having a very dull surface, assuming the photoelectric cell to have greater sensitivity to red light than to blue light. This difficulty cannot be overcome by any simple means in which white light is used to illuminate the samples. By use of filters or by using a spectro-

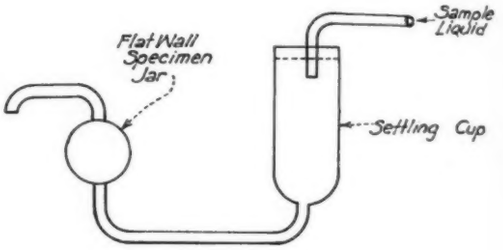


Fig. 2

photometric method, it is possible to differentiate between the intesity and color effects. In the latter method, which is in general quite elaborate, some sort of dispersion system—such as a prism—is required.

The balanced photoelectric photometer in the form described herein does not make provision for such differentiation, although special designs can be prepared in which one of the methods already named—that is, the use of filters or the dispersion system—can be used.

The fundamental circuit arrangement is shown in Fig. 1. Two photoelectric cells are used, both of which receive light from a single light source. The two cells are connected into a bridge circuit in which the galvanometer is connected between the common junction of the two cells and the junction of the resistances, R_1 and R_2. In quantitative measurements of this kind, it is advisable to use vacuum type cells, which are not critical with respect to operating voltage. Hence, the voltage of the bridge circuit may be any convenient direct current source of 90 to 200 volts.

The galvanometer should be one of high current sensitivity —that is, one having a sensitivity of approximately 10^{-9} amperes per millimeter deflection at a scale distance of one meter if the nature of the work requires high precision. Depending upon the means of balancing used, the galvanometer may be used to indicate balance or actually to measure the condition of unbalance. Upon studying the procedures described below, it will be obvious as to which method of measurement is most desirable in any particular instance.

For the measurement of opacity or percentage transmission of transparent or translucent materials, the optical arrangement shown in Fig. 1 may be used. A light source is

Measurements

By WM. J. KANTENBERGER
Southwest District Engineer
G-M Laboratories, Inc.
Chicago, Ill.

With the growing use of photoelectric cells in the oil industry, there is a rapidly increasing interest in the balanced photoelectric photometer of the two-cell type for measuring differences in opacity or transmission of translucent materials or solutions, differences in reflecting power of surfaces, and differences in color values of transparent or opaque substances.

mounted in a special housing having two aperture tubes in order that light from the lamp may be projected to both of the photoelectric cells. Cell No. 1 receives the light directly from the light source, or through a standard sample, while cell No. 2 receives its light through the sample to be tested. If this sample is in the form of a liquid or solution, a suitable specimen jar having plain and parallel sides is required. If the sample is in the form of strip or sheet material, such as paper, celluloid, etc., a suitable mounting rack should be provided for these materials in order that they may be quickly inserted and removed from the light beam. If it is desirable that a liquid sample be continuously tested, the arrangement shown in Fig. 2 may be used, in which a continuous flow of the liquid is maintained through the specimen jar in front of cell No. 2. The sample is continuously poured into a settling cup to permit all air bubbles to rise to the surface so as to leave the liquid, and the clear liquid then flows by gravity from the cup through the specimen jar, where its transparency is measured and from which it escapes through a short exit tube.

Obviously, the apparatus for mounting the specimen or sample should be shielded from the stray light in the room for extraneous light of this kind may be a source of considerable error. For occasional laboratory use, a black cloth may be placed over the specimen mounting at the time each measurement is made or a suitable light-tight mounting can be constructed for this purpose. Exact specifications of these details are not given inasmuch as each assembly should be designed to meet most conveniently the requirements of the particular work to be carried out.

If the reflecting power or color value of an opaque sample is to be measured, an arrangement similar to those shown in Figs. 3 and 4 will be required.

The arrangement of Fig. 3 is adapted to measure the reflecting qualities of a mirror-like surface such as polished or glazed materials. The arrangement of Fig. 4, on the other hand, is arranged so that the cells avoid the mirror, or glaze effect of the surface, and respond to the true color properties of the material tested.

Assume that the percentage of light transmission of a reasonably transparent material, such as celluloid, is to be measured in the optical arrangement of Fig. 2. Assume also that a standard sheet of the material is available against which comparisons may be made. Two samples of the standard material should be cut and one of them permanently inserted between cell No. 1 and the light source and the second one placed in the test rack between the light source and cell No. 2. The purpose of using the standard sample in the balancing light beam is to overcome insofar as is possible any errors arising from the color quality of the light. As a general rule any sample of material will absorb certain wave lengths of light more than others so that the light in passing through the celluloid or other material changes its color somewhat. From this it follows that unless substantially like samples are placed in front of each of the two cells, the very change of the color of the lamp filament due to slight fluctuations of voltage may introduce serious errors in the indications.

Having the two standard samples in place, it is now desirable to balance the circuit to give an indication that the sample has 100 per cent transmission as compared with the standard inasmuch as the sample now in the test rack is the standard. The bridge circuit is balanced by adjusting the two shutters until the galvanometer reads zero. Preferably one or both of the shutters is calibrated.

Assume that the shutter No. 1 is calibrated to indicate the amount of light passing through it as a percentage of some fixed value. Obviously the fixed value may be so chosen that the calibration covers any range desired as for example: zero to 10 per cent, zero to 100 per cent, or zero to 200 per cent. This calibration may then be used for taking readings and shutter No. 2 will serve as a balancing device. With the two standard samples in place, shutter No. 1 should be set at the 100 per cent point of its calibration and No. 2 adjusted to bring the galvanometer reading to zero. If now, the standard sheet in front of cell No. 2 is replaced by a sample whose transmission is not known and which is different from that of the standard, a deflection of the galvanometer will result. Calibrated shutter No. 1 should then be readjusted to return the galvanometer reading to zero. The calibration of the shutter No. 1 will then give a direct reading of the per cent transparency of the tested sample in terms of the transparency of the standard sample.

Thus if the test sample transmits only 80 per cent as much light to cell No. 2 as the standard sample did, the calibrated shutter No. 1 must be adjusted to reduce the light to cell No. 1 to 80 per cent of its former value in order to make the output of the two cells equal so as to bring the galvanometer reading to zero. The calibration of shutter No. 1 will then read 80 per cent to indicate the transparency of the test sample.

On the other hand, the shutter No. 2 might be calibrated and the shutter No. 1 be used as a balancing shutter. Shutter No. 2 should have a calibration reading in the reciprocal of its per cent opening. That is if its opening is cut to one-half the scale should read 200 per cent, etc. With the two standard samples in place, the calibrated shutter No. 2 should be set at its 100 per cent reading and shutter No. 1 adjusted to balance the system so as to bring the galvanometer reading to zero. Then upon putting the test sample between the light source and cell No. 2 and if the sample has an 80 per cent transparency as compared to the standard, a certain deflection of the galvanometer will result. To return the galvanometer to zero, that is, to re-balance the circuit, it will be necessary to open the No. 2 shutter 25 per cent to make up for the loss of light in the test sample. That is, the shutter opening must be enlarged to 125 per cent. However, the scale reads

1/1.25 = .8 that is 80 per cent, directly to indicate the transparency of the tested sample.

When two standard samples are not available, or when it

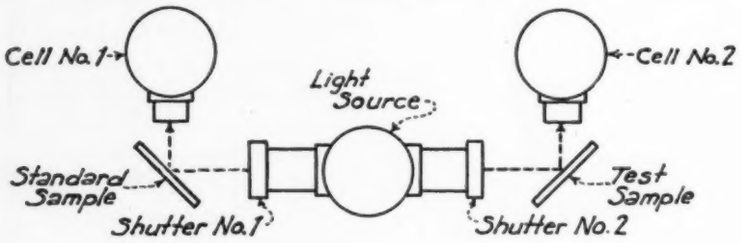


Fig. 3

is desired to compare the transparencies of two samples, the circuit should first be balanced by means of the shutters without the samples being in place. Both samples then should be put in place and the reading taken by one of the two above methods. The reading will indicate the per cent transparency of the sample in front of cell No. 2 as compared with the sample placed before cell No. 1.

If the lamp voltage can be maintained sufficiently constant readings may be taken directly by means of the galvanometer deflections as follows: With standard samples in front of both cells or with no samples at all, balance the circuit by means of the shutters. Then with the standard sample placed between cell No. 1 and the light source, insert an opaque object in front of cell No. 2 to cut off all the light therefrom. The galvanometer will then give a comparatively large reading, which is to be noted as 100 per cent absorption. Thereafter a test sample may be placed before cell No. 2 and the galvanometer reading noted. This reading may then be divided by the 100 per cent absorption reading to give the per cent absorption of the tested sample. The per cent transmission is then equal to 100 per cent minus the per cent absorption.

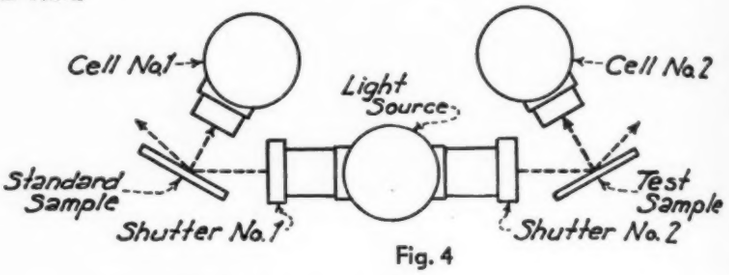


Fig. 4

How to Prevent "Geyser Action" in Steam

By W. F. SCHAPHORST
Mechanical Engineer

Fig. 1

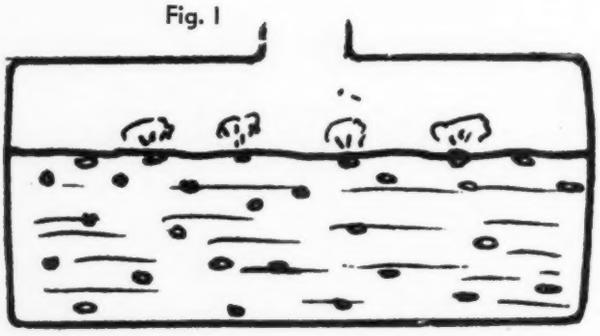
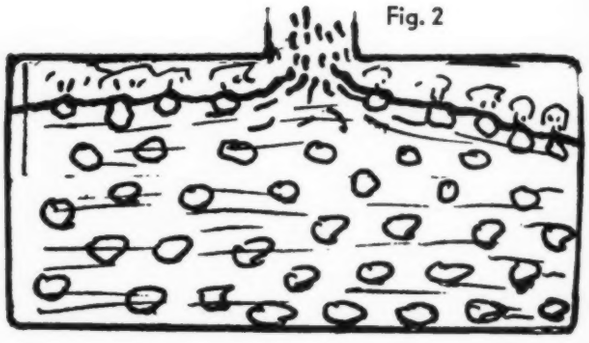


Fig. 2



BOILER operators in the refinery are often troubled with water in steam. Slugs of water are carried along with the steam, especially after a steam valve has been suddenly opened. Operating men often seek an explanation of this action, frequently called "geyser action."

In Fig. 1 the steam valve is closed. No steam is being used. The pressure in the boiler is, say, 200 pounds. There is a fire beneath the boiler and steam is being generated. That being the case, it is logical that throughout the entire body of water in the boiler we have small steam bubbles somewhat as pictured in Fig. 1. The size of these bubbles is dependent upon the pressure in the boiler.

Fig. 2 shows the same boiler with the steam valve suddenly opened. As soon as any valve is opened there always is a reduction of pressure within the boiler. Therefore in Fig. 2 the pressure is less than 200 pounds. Probably it is 195 lb. or even 199 pounds. Whatever it is, it is bound to be less than 200 pounds.

That being the case, the bubbles in Fig. 2 are certain to be larger than the bubbles in Fig. 1. The enlarged bubbles naturally increase the volume of water in the boiler; that is, they raise the water level. At the same time, with reduction in pressure, the water in Fig. 2 boils more violently. There is a rush of steam out through the opening. All these factors contribute toward "sucking" the water out, creating the "geyser effect." The only reason why such action occurs directly beneath the opening is that the flow of steam must be through the valve itself. The great velocity of steam in the neighborhood of the valve pulls the boiling water along with it in the form of slugs.

There are four ways in which to avoid slugs in steam—(1) by maintaining a low water level; (2) by using an outlet pipe so large that the exit velocity will not cause geyser action; (3) by installing a separator that will remove the water from the steam; and (4) by passing the steam through a superheater. A superheater will not only convert the water slugs into steam but it will give the steam a higher temperature than is ordinarily possessed by it under natural conditions.

Lack of roads a major problem, as shown by the above scene in the lava area

Transportation a Major Problem in the Construction of the Iraq Pipe Line

By WARREN L. BAKER

MODERN transportation equipment is playing a formidable role in the construction of a 1200-mile pipe line across the Syrian desert from the rich oil fields in Iraq, formerly known as Mesopotamia, to ports on the Mediterranean sea. Seldom has a more difficult task confronted engineering brains than the laying of this crude-oil carrier system, the most stupendous pipe line construction project ever undertaken in a foreign land. Most of the route lies across desert wastes and backward country that is practically devoid of roads of any kind — even railroads. To do the job automotive equipment has been requisitioned to haul thousands of tons of steel pipe and other essential supplies across long stretches of country practically untouched by the hand of modern civilization. In addition to the lack of roads, a major problem in itself, the extremes of climate, topography and soil conditions encountered render the movement of these heavy supplies across this vast area a vivid, compelling achievement in motor-truck transportation.

While the project is commonly spoken of as "the Iraq job," it actually includes operations in the four countries of Iraq, Syria, Palestine and Trans-Jordan. Starting at Kirkuk, Iraq, the line, a double one, follows a southwesterly course to Haditha on the Euphrates River. From this point the double line branches off into two separate systems: one, known as the northern or French section, going directly west through Syria to the port of Tripoli on the Mediterranean; the other, known as the southern or English section, continuing in a southwesterly direction through Trans-Jordan and Palestine to the port of Haifa on the Mediterranean. From Kirkuk to both seaports the total distance traversed by the line is 1000 miles; from Kirkuk to Haditha 150 miles; from Haditha to Tripoli 382 miles; and from Haditha to Haifa 465 miles. With 300 miles of pipe line in the 150-mile double section from Kirkuk to Haditha almost 1200 miles of pipe line construction will be required before the job is completed. A map showing the routing of the line was carried in a previous issue of *The Petroleum Engineer*.[1]

During the fall of 1932, preliminary field work on the line was actually started by the Iraq Petroleum Company. Today, construction work is in full swing and the sun-baked valleys and sand-swept hills echo with the clang of steel and the snort of powerful trucks and tractors. Construction work is at present ahead of schedule and it is likely that the entire project will be finished before its scheduled completion in June, 1934.

Everything must be kept moving smoothly in order that there will be no delays. Despite the extreme hardships encountered, trucking units have been successful in hauling pipe at a pace fast enough to keep ahead of the welding crews. Hauling equipment, as fast as it wears out, is rebuilt or replaced with new units so as not to incur a delay. A total of 583 miles of pipe, or approximately one-half of the total pipe, was strung in a few months' period ending January 1, 1933. This included 175 miles of 10-in. pipe strung from Tripoli eastward, 108 miles of 12-in. pipe eastward from Haifa, and 300 miles of 12-in. from Kirkuk to Haditha.

Since the first of this year approximately 300 miles additional have been strung, making a total of nearly 900 miles. Longer hauls account for the comparatively small mileage strung so far this year. The joints of pipe average 36 ft. in length and about 150 are strung to the mile. The average weight of each joint is three-fourths of a ton and when the line is completed 120,000 tons of steel pipe will have been laid. Loads of from 40 to 50 tons are hauled by the large trucking units and 5-ton loads by the small trucks. The cost alone of stringing pipe along the right-of-way per mile is between 30 and 40 pounds sterling, or $146 in U. S. currency at the normal rate of exchange.

Transportation of machinery and supplies is one of paramount importance in the construction of this line because of the great distances necessary to move materials and the lack of roads. Although transportation is one of the greatest difficulties encountered, it redounds to the credit of manufacturers that equipment for hauling has withstood successfully the severe tests to which it has been put on this project. In

[1] "The Iraq Pipe Line . . . It's Trade Importance . . . Construction Progress and Problems," *The Petroleum Engineer*, Vol. 4, No. 7, April, 1933.

A road of sorts was soon pounded out by the huge trucks

the daily grind of transporting essential supplies across this rough desert country with its lack of roads, water scarcity, high temperatures and wadis (gulleys or creeks) automotive equipment is up against some of the most difficult, but none the less interesting, trucking problems ever encountered in the petroleum industry or elsewhere. Forty million dollars may seem a high cost for a 1200-mile crude-oil transporting system, but to those who have spent a year in the Near East working on the Iraq line and know the obstacles that must be overcome it is a constant source of wonder that the expenditure is not greater.

Difficulties of every description are faced; in addition to ordinary construction problems a constant battle has to be waged against blowing sand, surface lava beds, mud, salt marshes and water shortage, to say nothing of unidentified routes, lack of communication, a ploy glot of languages, insects and diseases. Some of these obstructions actually overshadow the topographical and other problems that ordinarily confront engineers in the United States.

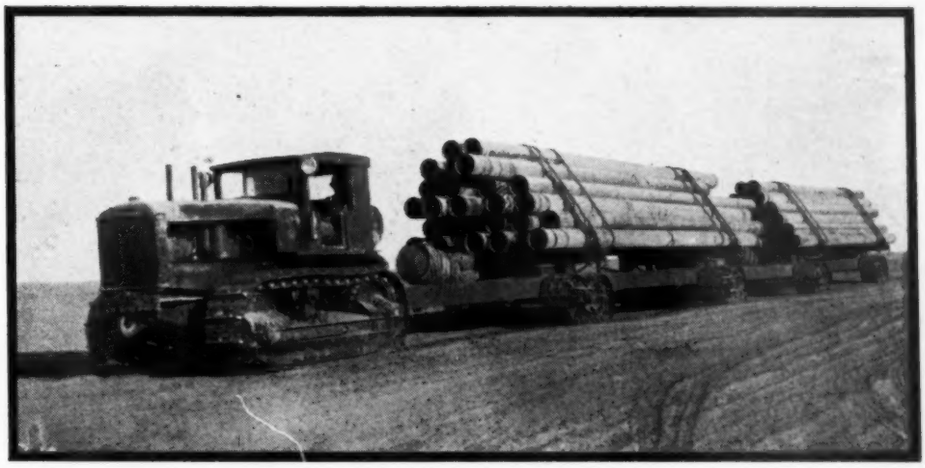
Travel is almost entirely cross-country and follows the route of the pipe line through the mountainous lava regions around Mafrak (85 miles east of Haifa on the southern route) thence out across barren, rock-strewn desert into rolling (but still desert) country, where the sand is hub-deep in places and as loose as sugar. Salt marshes, the valleys of the Tigris, Euphrates and Jordan Rivers and many "wadi" crossings, with their steep inclines, add to the hazards. In the lava country the surface is strewn profusely with fragments of loose rocks ranging in size from a pebble to huge boulders several feet in diameter, and make travel almost impossible in places. The worst region for desert sand is encountered between Haditha and Baija, a section where wheeled traffic, unless it be of the multi-wheel or caterpillar-type, is almost out of the question. Travel along the route from Haditha to Tripoli is much better than on the southern route and is not so hard on motor equipment. In many places along the two routes it has been necessary to clear a trail, over which hauling operations must be confined. The top soil is generally a fairly firm, sun-baked crust about 4 in. thick, beneath which an ash-like dust forms a snare for heavy loads. The minute the crust is broken, or ruts break through it, hauling conditions become almost unbelievably bad. Many tractors are being used in making and maintaining the long trail that leads from Kirkuk to the sea. Although the elevation of the route averages 2000 ft. above sea level, it varies greatly, particularly in the mountainous region near the west and of the southern route, where it changes from 850 ft. below sea level in the River Jordan valley to 3150 ft. above sea level across the slope of an extinct volcano less than 100 miles to the east.

High winds whip up the fine sand to such an extent that frequently the drivers cannot see 10 ft. ahead. On several occasions truck caravans have become lost in these sandstorms, which usually follow a prolonged period of high temperature. They are most uncomfortable while they last as the sand penetrates everywhere and drifts across the trail, forming huge sand dunes that become veritable dry quick-sands, into which the tracks of the tractors or the wheels of the trucks sink suddenly out of sight, much like an automobile in the northern United States during a mid-winter snowstorm, thus causing the truck to be stranded in the desert, until assistance is obtained to dig it out.

The summer temperature is almost without exception greater than 100 deg. fahr. during the day, and not uncommonly reaches an average of 135 to 145 deg. on the desert, where there is no shade, and the only vegetation is camel wire, a sharp and brittle thistle upon which camels munch. Frequently on a trip the levers in the cab become so hot that they cannot be touched with the bare hand, nor can the arm be laid on the window-ledge of the cab without burning it. Even at night, the average summer temperature is 95 deg. fahr. over the greatest part of the line. Although the cabs of the tractors and trucks give protection from the sun during the day, the heat within the cab often becomes almost unbearable and operators have to work under almost suffocating conditions. One of the early mistakes made was the building of portable sheet-iron houses as quarters for the white workers. This type of building became a veritable oven during the day and would rarely cool off enough during the night so one could sleep. The adobe or mud huts of the native type are more satisfactory and most of the workers used them wherever possible. However, this condition has been overcome by the erection of wooden dwellings.

Tractors and trucks are manned by natives of the country, who are very unfamiliar with the mechanical details of the unit they are driving. They are always at a loss to adjust any breakage or mechanical difficulty encountered en route. Although willing enough to work, they are not at all mechanically-minded and cannot be depended upon to handle equipment without constant supervision. Chains, ordinary nuts and bolts, hay wire, miscellaneous assortments of screws and washers frequently become extremely important accessories when difficulties arise during trips across the desert.

It is sometimes necessary for a truck to make a solo trip across the desert, a practice that is not generally encouraged



A tractor with a 40-ton load ready to cross the desert

in these regions, due to the dangers of becoming stalled or lost en route. In many instances, a guide, usually a white person, has to accompany the convoy to pick out the most suitable routes. He may have to walk for miles in order to guide the convoy properly and to instruct the drivers, who have no knowledge at all of how to meet critical situations. Though the camel is well adapted to carrying loads in the desert, they are afraid of motor trucks, hence seldom can be used in conjunction with a convoy.

All the carriers of supplies are, as a rule, convoyed by soldiers for protection against raids by nomadic tribes. It is a custom of these raiders to strip the victim, even his hat and hose being taken, and leave him naked on the desert. However, it is only in rare instances that a band of desert raiders really do any serious damage, because for the most part the natives are all more or less friendly. In the tents of the natives hospitality rules, and no foreigner could be better served with rice, dates, flour and mutton. The greatest treat is to be served with the eyes of the lamb. But in the desert, you're anybody's game. British law reigns in the camps but not in the desert, where the only law known is an eye for an eye or a tooth for a tooth. With the exception of the Trans-Jordanian people, none of the natives are permitted to carry weapons. In Trans-Jordan roving desert tribesmen are more apt to raid a caravan and so these people are allowed by the British Government to carry firearms, knives, or whatever weapons their fancy dictates for their own protection.

The large number of insects prevalent in these lands are a great nuisance and an actual hazard to health. Mosquitoes and winged pests are found in large numbers and as a rule are disease carriers. Officials of the Iraq Petroleum Company have taken precautions to keep the quarters as free as possible of all insects, and competent physicians are retained in all camps to keep the various contagious diseases in check. Particularly annoying are the centipedes and scorpions, whose bites are very painful, being greatly feared by white and natives alike. These pests lurk under sticks and stones and are very abundant in number.

There probably is no place in the world where begging is so prevalent; it is truly the great national pastime and every other youngster on the street is seeking alms. Natives are habitual hitch-hikers and though they haven't acquired the American professional hitch-hikers' thumb, the stories they can tell are truly amazing. The stock story, however, is that they have a sick relative in the next town and it is very important that they see said relative as soon as possible. As the regulations of the Iraq Petroleum Company necessarily are quite strict in regard to carrying non-employees on any of the trucks a lot of good stories go unheeded. Hikers do not always ask permission but merely climb on the slow-moving vehicles, and in this respect are quite annoying.

The vast amount of hauling and the constant usage of trucking equipment cannot be realized until some of the mileage records are studied. During the month of December, 1932, one large truck covered approximately 5000 miles. It hauled 1050 lengths, or almost eight miles, of pipe, of which the largest single haul was 38.10 long tons or 42 short tons actual pay load. Three thousand and eighty-three gallons of gasoline were consumed during the month or 1.61 miles per gallon. The principal accomplishment as computed from the December figures was the record of 79,490 ton miles of transportation in 30 days by this trucking unit, this being figured on the basis of long tons hauled multipied by one-half the daily mileage. This truck was in practically constant operation during the month. It was in service 22 days out of 30, with two days' time out for the Christmas holidays; two other days were required to change bolsters in order to load the size of pipe to be hauled. Handling such loads across country where no roads exist at a 20-mile-per-hour average and repeating this day after day is a performance that speaks for itself.

Trucks of various makes, English, French and American, the total value of which runs into thousands of dollars, are in service on the line, besides, there are numerous tractors in use for hauling in the more inaccessible places and for other hard duties. Many types of service are demanded of these transportation units and include the hauling of pipe, tank plates, supplies and equipment; backfilling pipe-line ditches; pulling compressors; boring telephone post holes; stringing telephone wire; removing boulders; making and maintaining roads. Most of the mechanical vehicles in use are of American make, particularly the larger units. These trucking units are shipped to Haifa, Palestine, where they are generally assembled on the dock, a task in itself considering the lack of suitable shop equipment.

A total of 81 Trackson McCormick-Deering Crawler-Tractors, made by the International Harvester Company and the Trackson Company, are in use on the job. Most of these are Model "G" and are being used in the actual pipe-line construction work, for which they have been equipped with pipe booms, backfillers and winches. Model "GH" tractors of the same manufacturers have been equipped with earth-boring machines and are in use for boring the telephone post holes.

Construction work on the Iraq pipe line

Of 64 motor trucks of the International Harvester Company in use on the line, 48 are Model "B-2," 1½-ton, 6-speed trucks of 136-in. wheelbase; nine of Model "A-4," 2-ton trucks, four of which are equipped with winches; five Model "A-5," 3-ton trucks; one Model "A-7," 5-ton heavy-duty motor truck; and one Model "A-8," 7½-ton heavy-duty truck.

The Allis-Chalmers Manufacturing Company's equipment on the job includes: Five Model "L" tractors; six Model "35"; 20 pipe-carrying wagons and six 10-ton utility wagons, which are used for hauling material to build roads. In the first test run of the Model "L's," the round trip from Baiji to Haditha, a distance of 194 miles, was covered in 88 hours. Each tractor pulled two trailers loaded with a total of 70 tons of 12-in. pipe, with a fuel consumption per mile of 2¾ gallons. Dan W. Hiner, of the company's export department, spent nine months in the Iraq desert erecting and supervising the operation of these tractors and wagons.

Tractors of the Caterpillar Tractor Company in use on the line number 11 in all. Five of these are Model "65" and six are Model "35." These tractors are used for hauling pipe and supplies, clearing the desert trails of boulders, building roads and lending a steady hand when trucks and other hauling equipment become stalled in the treacherous gypsum dust. The first job assigned to the "65's" was hauling supplies from Kirkuk to Baiji, a distance of 94 miles. On this work they hauled net loads ranging from 60 to 70 tons, which were carried on special Athey Truss trailers. The Athey Truss Wheel Company has ten 30-ton capacity trailers and six trailers of 10-ton capacity on the line.

A 15-ton truck of the Four-Wheel-Drive Auto Company is in service. This truck is of the 6-wheel heavy-duty type, with all wheels driving. The unit has eight speeds forward and two in reverse. The FWD is detailed to haul supplies and tank plates to the various Iraq Petroleum Company camps, and at times has been called on to fill in on the pipe hauling jobs. M. E. Giersback, special representative of the company, went to Iraq and superintended the assembling of the truck and its first work in the desert. His various trips took him to Damascus, Rutba, Bagdad, Haitha, Baija, Homs and Tripoli, with general headquarters being maintained at Haifa.

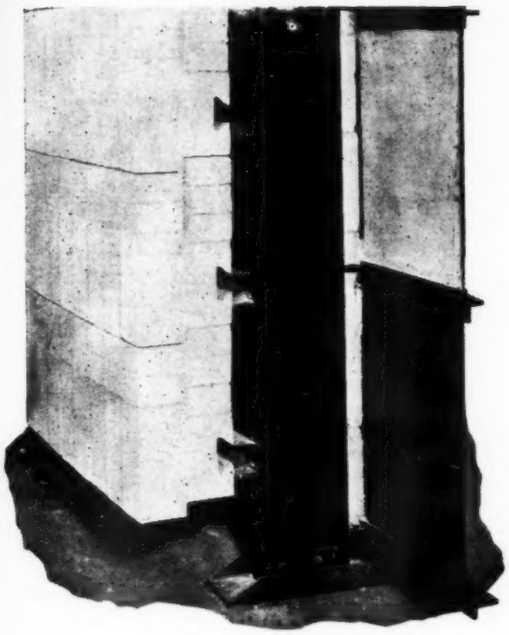
What is believed to be the largest equipment of its kind ever produced is being used by the Iraq Petroleum Company. It consists of a truck-tractor, semi-trailer and trailer with a combined weight of 20 tons. An idea of the size of this equipment may be gained from the fact that the overall length is exactly 100 ft., and that there are 30 tires on the ground, that a total of 150 gallons of gasoline is carried, and that the weight of the bolsters and chains necessary to hold the pay load is equivalent to the weight of the average passenger car. The transmission system has 12 speeds forward and three reverse. It utilizes a 6-wheel drive. Despite its gigantic size, the equipment may be handled easily, as far as steering, braking, etc., are concerned, and it can turn around in a 90-ft. circle. The unit was specially designed by the Marmon-Herrington Company, Inc., and A. W. Herrington, president, personally supervised its use in Iraq for several months. In the month of March, the equipment amassed the astonishing total of 119,478 ton-miles across the barren desert wastes. A total of 6,286 miles were covered during the month and more than 913 long tons (2240 lb.) of pipe were hauled. Each load consisted of 50 lengths of 12-in. steel pipe. The average weight of each load was more than 38 long tons. At this time the equipment had traveled more than 30,000 miles without necessity of a single major repair operation. The record of this unit has been so satisfactory that three additional trucks like it are being placed in operation on the pipe line. The new units are similar to the first except that they have slightly larger pay-load capacities. Each will haul up to 50 tons of pipe as compared to 40 tons hauled by the original equipment.

Ten White trucks of 10-ton capacity each, two of which are fitted with Mead-Morrison winches, are also in service in this desert country. The trucks are of the heavy-duty type, with six wheels, four of which are driving wheels. The White Company also furnished ten 4-wheel-pull trailers to be used with the trucks.

Plans have been made to construct a highway along the route of the pipe line and when this is completed, it will mean much to the progress of the various countries through which it passes. At present travel between Kirkuk, Bagdad and the Mediterranean sea is very irregular as convoys of cars are made up only at infrequent and unscheduled intervals. Airplane travel is, of course, used to some extent, but does not offer much in accommodating freight and heavy pieces of mail, so that in construcing this 1200-mile pipe line the Iraq Petroleum Company has to depend almost entirely upon motorized vehicles of the ground type.

By
Geo. P. Reintjes ☆

Air-cooled Furnace Walls



Air-cooled furnace wall

THE circulating air in the air lanes of the so-called furnace walls actually does not cool the face of the refractories exposed in the furnace. It is the circulating air that is preheated. The air is preheated by absorbing heat that has been generated in the furnace. It is transferred through the refractory lining to the air in three ways: First, by radiation through the joints between the tiles. Radiating heat is most effective at right angles and consequently penetrates into rectangular joints or openings. Second, by the absorption and dissipation of heat through the tile supporting metal. Third, and least of all, by the transfer of heat through the refractories themselves.

In most walls, the refractories are cooled by operating the furnace so there is a lesser pressure within the furnace than in the surrounding (cooling) air lanes and allowing the circulating air to leak from the air lanes through the joints of the refractories into the furnace. This, however, is accomplished at the expense of furnace efficiency. If this excess air filters through the wall above the tube line, the loss is still greater.

A very good example of where spaces are left between the brick purposely for the infiltration of air to prolong the life of the refractories, is in open-hearth furnaces. To build a tight setting that is a tight setting after the silica brick, which is commonly used, has reached its maximum expansion would materially decrease the life of the installation. If, on the contrary, you have a greater pressure in the furnace than in the surrounding air lane, the reverse is true. With a negative pressure within the furnace, the more open the joints between the tiles, the lower will be the wall temperature. Also the lesser will be the amount of preheat available for the circulating air.

It is well known that metal will absorb, as well as dissipate, heat from 36 to 45 times, or an average of approximately 40 times, as rapidly as refractories. Thus, the nearer the supporting metal castings are to the furnace face of the refractories the greater the temperature they will be exposed to, and instead of cooling the rear faces of the refractories, the metal will actually heat that portion of the refractories farthest from the fire. For the same reason, metal should be kept as much as possible out of the joints between the refractories.

When the preheated air taken from the furnace does not function as a cooling medium for the refractories, how can the radiation losses be reduced to a minimum? By so designing the air lanes and casings that the heat is not lost to the atmosphere but can be returned as preheated air for combustion. Unfortunately, the heated air does not travel in strata, namely, the hotter air lanes near the refractories and the cooler air lanes near the casing. On the contrary, there is a continuous circulation of air from the comparatively hot wall surfaces to the cooler casing wall, transferring the heat from the furnace lining to the casing by conduction as well as by radiation.

As the thermal conductivity in B.t.u. per sq. ft. per deg. fahr. per in. per hr. in iron is approximately 150, that of the refractory brick ranging from 6 to 12, and that of insulating material an average of ½, it can be readily seen that you will have several times as much heat loss through columns projecting through the casing as you will have through the entire insulated surfaces between the columns. In insulating the air lanes so as to save the preheated air, it is imperative that the metal supporting the walls, whether that metal be columns or beams, does not project through the insulated casing.

In most so-called air-cooled furnace walls more than half of the preheated air is lost to atmosphere by radiation through the casing. If the casing be of metal and uninsulated, practically all the preheated air is lost. We have found it much more desirable to use asbestos lumber than to use steel plates.

The writer has carefully watched the operation of two still furnaces having supported air-cooled walls that were erected with identical walls. On one still, the preheated air was not used for combustion because a preheater was installed in the stack gas flue, the combustion air being preheated by the waste stack gases. The air was allowed to enter at the bottom of the walls, circulate upward and out the walls at the top. In the other furnace, the air lanes were closed both at the top and the bottom so that no air could circulate to the atmosphere, yet as nearly as could be determined, the heat losses were as great on the furnace without the air circulation as on the one with the air circulation.

In designing a supported wall it is always desirable to keep the total thickness of the refractories as nearly uniform as possible. Should the wall tiles be of varying thickness the temperature gradient is different through the thick portion of the tile than through the thinner portion. The different thicknesses of the tile will create internal strains within the tiles that will induce cracking or spalling.

On oil stills it is seldom necessary or advisable, to air-cool the refractory wall. While the supported wall reduces the wall maintenance on stills to practically nothing, still leakage of air through many of the common types of walls causes secondary combustion, which has been the cause of the refiners spending thousands of dollars replacing burned-out tubes.

☆ Geo. P. Reintjes Company.

Gas Compressor Station Operations and Operating Records

By C. S. WORLEY
Chief Engineer
Consolidated Gas Service Company

Comprehensive detailed information reduced to concise form gives readily understandable picture of efficiency of operations

WITH the enormous capital investment involved in a system of gas-compressing stations, it is very desirable that complete and accurate records be kept pertaining to immediate operating and maintenance costs, as well as of those things that affect the efficiency and useful life of the equipment. Without this detailed information, which should be reduced to concise and comprehensive form, it is impossible for the executive in charge of operations to determine whether or not he is getting the best possible results.

No doubt some gas transmission companies go much further than others in procuring this information, and particularly in analyzing and condensing it with a view to increasing plant efficiency and holding operating and maintenance costs to a minimum.

At each compressor station a daily log sheet should be kept that will give a complete record of the day's operations. We have found that a double sheet about 17 in. by 22 in. in size is required to record all essential detail, regardless of the size of the plant or the number of units installed, with provision for recording observations every two hours.

The speed of each compressor in service is determined by the use of a speed indicator and stop watch; also, the intake and discharge pressures are noted, as well as the temperature of the gas, both before and after it is compressed, and again after it is passed through the cooling coils. The water temperature is taken before it enters, and again as it leaves the engine and compressor jackets. Soap tests are made regularly to determine the hardness of the water and a record made of the amount of raw water treated and added to the system. (A water softening plant is provided for each station). The amount and grade of lubricating oil going into each lubricator or crankcase is registered whenever oil is added and special notation is made when a crankcase is cleaned and refilled.

Atmospheric temperatures and general weather conditions are recorded at each station every two hours throughout the year whether the plant is operating or idle.

A complete record is also made of everything affecting the auxiliary equipment: engines, boilers, motors, generators, air and water pumps.

The fuel gas consumed is computed each day by the plant superintendent. Gas for the main engines, auxiliary equipment and residences is usually passed through separate meters. These computations are shown on the daily reports.

Each plant superintendent calculates the volume of gas pumped for the 24-hour period, based on piston displacement. This is determined from the average speed of the compressors and the average pressures. Curves showing the theoretical volumetric efficiency at varying pressures are provided for each station, and the proper factors applied. These computa-

Sheet No. 1

GENERAL SUMMARY OF COMPRESSOR STATION OPERATIONS
For the Year Ended December 31, 1932

	M. Cu. Ft. Gas Compressed As Metered	Cylinder Displacement M. Cu. Ft.	Observed Volumetric Efficiency	Average Intake Pressure	Average Discharge Pressure	Average R. P. M.	Total Engine Hours Operated
CARPENTER STATION							
First Quarter							
Second Quarter							
Third Quarter							
Fourth Quarter							
TOTAL							
AVERAGE							
EAGLE CITY STATION							
First Quarter							
Second Quarter							
Third Quarter							
Fourth Quarter							
TOTAL							
AVERAGE							

ALL OTHER STATIONS ON SYSTEM ARE SHOWN IN SIMILAR FORM

Sheet No. 2

GENERAL SUMMARY OF COMPRESSOR STATION OPERATIONS
For the Year Ended December 31, 1932

	Operating Labor	Fuel Gas @ c Per M. Cu. Ft.	Lubricating Oil Less Tax	Maintenance of Station Equipment	Miscellaneous Supplies & Expense	Taxes & Insurance	Total Expense	Cost of Gas Compressed Per M. Cu. Ft.
CARPENTER STATION								
First Quarter								
Second Quarter								
Third Quarter								
Fourth Quarter								
TOTAL								
AVERAGE								
EAGLE CITY STATION								
First Quarter								
Second Quarter								
Third Quarter								
Fourth Quarter								
TOTAL								
AVERAGE								

ALL OTHER STATIONS ON SYSTEM ARE SHOWN IN SIMILAR FORM

tions usually coincide very closely with the main line check meter measurements.

A copy of these daily reports comes to the writer's desk each morning covering the previous day's operations. With this full information it can be seen at a glance whether conditions are normal. Should things appear out of line at any particular plant, a telephone call often gets it rectified without the necessity of a trip to the station, though frequent visits are made for inspection.

It is probable that most gas companies keep somewhat similar records of daily operations, but this information, in itself, is not sufficient to give a complete picture of results over a period of time. With additional data from the accounting and gas-measurement departments of the company, this accumulation of information is summarized, first into monthly, then quarterly; and finally, at the end of the year, into an annual report, covering all stations.

To begin with, the most vital information from the daily operating reports is transferred to a monthly summary sheet for each station. This includes the hours operated for each unit, the average intake and discharge pressures, as well as the average speed of all units. Each day's results are listed and a weighted average obtained for the month.

The piston displacement is then calculated and the factor

SUMMARY OF COSTS—COMPRESSOR STATION OPERATIONS
For Year Ended December 31, 1932

	Carpenter	Eagle City	Enid	Hunnewell	Wichita
Amount of Operating Labor—Cost					
Cost of Fuel Gas @—c Per M. Cu. Ft.					
Cost of Lubricating Oil—Actual—Less Tax					
Cost of Maintenance—Station Equipment					
Cost of Miscellaneous Supplies & Expenses					
Cost of Taxes and Insurance					
TOTAL OPERATING EXPENSE					
Number of Compressors and Make					
Rated Hp. Plant					
Possible Engine Hours for Period					
Operated Engine Hours for Period					
Per Cent of Plant Operated					
M. Cu. Ft. of Gas Compressed					
Total Compressor hp.-hr.					
Ratio of Discharge to Intake Pressure					
Cost of Fuel Per M. Cu. Ft. Gas Compressed					
Cost of Fuel Gas Per Compressor hp.-hr.					
Cost of Fuel Gas Per Installed Rated hp.					
Cost of Fuel Gas Per Operated Rated hp.					
Cost of Lub. Oil Per M. Cu. Ft. of Gas Compressed					
Cost of Lub. Oil Per Compressor hp.-hr.					
Cost of Lub. Oil Per Installed Rated hp.					
Cost of Lub. Oil Per Operated Rated hp.					
Cost of Operating Labor Per M. Cu. Ft. Gas Compressed					
Cost of Operating Labor Per Compressor hp.-hr.					
Cost of Operating Labor, Installed Rated hp.					
Cost of Operating Labor, Operated Rated hp.					
Cost of Maintenance Per M. Cu. Ft. Gas Compressed					
Cost of Maintenance Per Compressor hp.-hr.					
Cost of Maintenance Per Installed Rated hp.					
Cost of Maintenance Per Operated Rated hp.					
Total Operating Cost Per M. Cu. Ft. Gas Compr.					
Total Operating Cost Per Compressor hp.-hr.					
Total Operating Cost Per Installed Rated hp.					
Total Operating Cost Per Operated Rated hp.					

COMPRESSOR STATION

Location_____ 24 Hours Ending_____ A. M._____ 19____

	Unit No.	8 AM	10 AM	12 AM	2 PM	4 PM	6 PM	8 PM	10 PM	12 PM	2 AM	4 AM	6 AM	Total Or Avg.
	1													
Speed	2													
Record	3													
Of Each	4													
Engine	5													
In Service	6													
	7													
	8													
	9													
	10													
	1													
Temperature	2													
Of Overflow	3													
Jacket	4													
Water From	5													
Each Engine	6													
	7													
	8													
	9													
	10													
Intake Gas Pressure														
Discharge Gas Prssure														
Intake Gas Temperature														
Disch. Gas Temperature														
Temp. From Gas Coolers														
Temp. Water to Coolers														
Temp. Water From Coolers														
Atmospheric Temp.														
Weather														

AUXILIARY REPORT

Speed Record of	1													
Auxiliary Engines	2													
Voltage														
Amperage														
Water Pumps	Nos.													
Air Compressors	Nos.													
Water Tank Gage														
Drips Blown														
Wells Pumped														
Boiler Pressure														

WATER TREATING PLANT

Time in Service	Soap Test Drops	Previous Mtr.Rdg.	Present Mtr. Rdg.	Gallons Treated	Salt Used	Salt On Hand

OPERATING REPORT

LUBRICATING OIL RECORD

	No.	Lubri-cators	Crank Cases	Crank Cases Cleaned	LUBRICATING OIL STOCK					
					Grade	On Hand Yesterday	Received Today	Total	Used Today	Remain On Hand
	1									
	2									
	3									
Main	4									
Engines	5									
	6									
	7									
	8									
	9									
	10									
Auxiliary	1									
Engines	2									
Generator Bearings										
Motor Bearings										
Water Pumps										
Air Compressors										

FUEL GAS METERS

	Today	Yesterday	Cu.Ft.Consumed
Main Engines			
Auxiliary Eng.			
Boilers			
Residences			

ENGINEER'S SIGNATURES

8-4

4-12

12-8

OILER'S SIGNATURES

8-4

4-12

12-8

PLANT SUPT.

Engine Hours Operated	
Average R.P.M.	
Average Intake Pressure	
Average Discharge Pressure	
Cubic Feet Gas Compressed	

REMARKS—MAIN ENGINES

REMARKS—AUX. ENGINES

corresponding to the average pressures is applied. This result is then divided into the gas volume as recorded by the main line check meter to determine the volumetric efficiency of the plant.

Fuel gas consumption and lubricating oil used are also shown on this monthly summary sheet, under proper headings.

At the end of the three months' period the information thus assembled is further summarized into a quarterly report and the results obtained at the various plants compared. The annual report is compiled from these quarterly statements and a general, weighted average for the year, of each station, is computed.

In the first column of this general summary sheet is shown "M Cubic Feet of Gas as Metered." Next is listed "Cylinder Displacement at Existing Pressures in M Cubic Feet." Then follow in order, "Observed Volumetric Efficiency," "Average Intake Pressure," "Average Discharge Pressure," Average r.p.m." and "Total Engine Hours." The next division of the summary that carries operating expense includes: "Operating Labor," "Fuel Gas @.....c per M Cubic Feet," "Lubricating Oil—Less Tax," "Maintenance of Station Equipment," "Miscellaneous Supplies and Expense," "Taxes and Insurance," and a "Total Expense" column.

Against each quarterly total is shown the cost of pumping gas per 1000 cu. ft., and the general weighted average for the year is determined and set opposite the general averages of all items.

But it is found to be unfair to some stations to compare results only on the amount of gas pumped, as operating conditions are so vastly different at the various plants.

At some points operations continue throughout the year, while at others the plants may be shut down from four to six months during the warmer weather. An operating force is maintained, even though the plants are idle, and, too, taxes, insurance and other fixed charges continue the same as though the plants were operating. For this reason the best comparisons of the different plants can be made for the first and last quarters of the year when the stations are all running with reasonable regularity.

But even during the season when most of the equipment throughout the system is in service, some stations, on account of excessive demand in certain localities, may have a much greater load than others where the deliveries are less. When the differential pressure range is greater, the energy required to pump a given volume of gas is necessarily more. Also, the fuel gas and lubricating oil consumption is increased per 1000 cu. ft. of gas pumped, all of which increases the unit cost of compressing. On this account, it is felt that reducing all operations to the basis of compressor horsepower hours, which represents the actual work performed, gives a much more equitable basis for comparison of operations at the different plants—especially during the time when all stations considered are in service.

However, we make two still further comparisons of operating cost, each of which reflects conditions that do not show in either of the aforementioned. One is on the basis of "Installed Rated Horsepower of the Plant"; the other takes into account only the "Operated, Rated Horsepower" of each station.

With the record of "Engine Hours Operated" for each unit of all plants kept and summarized, and the total of each engine for the year added to the totals brought forward from previous years, the engineers watch the operated time for each unit and see that the running time is kept equalized throughout each station. The plant superintendent posts on a bulletin board the first of each month the "Total Hours Operated to Date" for each unit of his station and the operators are instructed to keep on the line those units that have had the least service until the operating time is equalized.

Each compressing unit is completely dismantled and all parts carefully inspected once a year, during the period when the load is lightest. All plant superintendents are required to do their own repair work with the aid of their regular operating force. This gives the superintendent, as well as the engineers, a greater working knowledge of their equipment, and more confidence in their ability to handle any trouble that might develop.

As each engine is dismantled, bearings and all working parts are closely inspected. If any new parts are needed, as replacements, a record is made of all such parts, designating the particular unit on which they were used.

Micrometer measurements are also taken of all engine and compressor cylinders. In case of horizontal engines, both vertical and horizontal measurements are obtained, and these are made and recorded at three different locations in each cylinder; one near each end and one about the middle. Should greater wear appear near one end of the cylinder, it may indicate improper adjustment of tail guides, or again, it may be traced to imperfect lubrication. At any rate, the cause should be easily determined while the engine is torn down, and precaution can be taken to eliminate further excessive wear from the same cause.

As these measurements are carefully taken and recorded each year, it is possible fairly to estimate the life of the cylinder or liner and to anticipate within reasonable limits the time when the liners must be replaced or the cylinders rebored.

On a horizontal power cylinder of from 18-in. to 20-in. bore, wear of from .0015 in. to .0020 in. per 1000 engine hours is not deemed excessive, while the compressor cylinders, pumping clean natural gas, should not register more than 50 per cent of that amount.

It is considered much better operating practice to use a soft piston ring, with good tension, even though it is worn out in a single season, than to put in hard rings that might give longer service, but would, of necessity, cause a greater amount of wear on the cylinder walls.

After years of experience, it is our opinion that any standard equipment, properly installed and adjusted, with an adequate supply of good cooling water, and with proper lubrication, should give little operating trouble. But no gas company can afford to operate for a single season without a complete system of records that will reflect true conditions and results. And these should be not only for the day's operations, but should represent part of a life history, which should be written for every gas-compressing station operated.

Cracking

Article I. Design Data

By W. L. NELSON

Professor of Petroleum Refining,
University of Tulsa

WHILE data on cracking are not yet so complete as we desire, nevertheless, it is complete enough so that definite conclusions can be gathered regarding any phase of cracking. The purpose of the following paper is to present and correlate as completely as possible the data that are available.

Cracking is a phenomenum by which large oil molecules are thermally decomposed into smaller and lower boiling molecules. While gasoline is the common light product from cracking plants, all the intermediate oils boiling between the cracking stock and gasoline are also produced. However, these stocks of intermediate boiling range are held within the cracking system until they are decomposed. This may be accomplished by operating at a high pressure in a batch system or by recycling in a continuous system. Higher-boiling materials (tars, etc.) are also produced along with the lower-boiling materials. These are produced by secondary reactions involving polymerization of active molecules produced by decomposition. Decomposition is a primary reaction and the polymerization of these decomposition products constitutes the secondary reactions. As an example the following reactions indicate the two types of reactions, although no experimental evidence has been presented to prove that these exact reactions take place:

$$2\ C_5H_{11}CH_2CH_2CH_2C_6H_{13} \longrightarrow 2\ C_5H_{11}CH : CH_2 + 2CH_3C_6H_{13}$$

$$2\ C_5H_{11}CH : CH_2 \longrightarrow C_5H_{11}CH_2CH_2CH : CHC_5H_{11}$$

Decomposition produces low-boiling oils such as gasoline and gas and polymerization produces tars and even coke if the cracking is continued to an extreme.

The properties of the products produced during cracking depend greatly upon the extent of cracking that is practiced. Sakhanov and Tilicheev[1] have made a study of Emba (Russian) gas oil to determine the properties of the products produced from stocks cracked once, twice and several times. In each cracking test the oil was cracked at 450 deg. centigrade. The fraction boiling between 200 deg. cent. and 350 deg. cent. was distilled from the products of cracking and cracked again at 450 deg. centigrade. The extent of cracking on each recycle oil was not exactly the same, nevertheless, a qualitative comparison of the yields and gravities produced from each recycle stock is interesting. Table 1 presents their data.

TABLE 1

Number of Operations	Time Minutes	Yield % by weight Below 200°C.	Residue above 350°C.	A. P. I. gravities Cracking Stock & Recycle Oils	Below 200°C.	Above 350°C.
1	42	28.7	10.5	30.8	58.2	10.6
2	52	21.3	8.6	28.2	52.5	1.05*
3	75	16.3	7.9	23.8	46.0	1.116*
4	101	12.1	10.3	19.2	38.4	1.177*
5	101	3.9	12.4	15.4	37.1	1.157*
6	160	8.0	19.0	14.5	30.6	1.243*

*Specific gravity.

[1]Oil and Gas Journal, p. 48, November 19, 1929.

Notice the 30.6-deg. A.P.I. 392-deg. fahr. cut-point gasoline produced from the six-times cracked stock.

Sydnor and Patterson[2] have studied a Mid-Continent gas oil and cycle gas oils produced from it, in somewhat a similar manner. Their experimental equipment simulated plant operation more accurately and they present more complete data than Sakhanov and Tilicheev.[1] The Furol viscosity at 122 deg. fahr. of their tars ranged from 210 for the tar produced by a single crack to 18 for the tar produced in the fourth crack. Likewise the insoluble sediment in the fuel oil increased from 0.018 to 0.37 for these same tars.

Egloff[3] reports the analysis of straight-run and cracked gasolines. The percentages of paraffins (the worst "knockers") and of naphthenes is less in cracked gasolines but the unsaturates and aromatics (highly anti-knock) occur in large percentages.

All cracked gasolines have higher octane numbers than straight-run gasolines from the same parent stock. The octane numbers of gasolines produced from gas oil and topped crude have not been completely studied. If the stock is naphthene base such as many Coastal, California, Texas and Mexican stocks, the octane number of the cracked gasoline will be higher (80 to 90). From normal stocks the octane number usually ranges between 72 and 80. Higher numbers are obtained at higher temperatures and pressures even in the liquid phase and in vapor-phase cracking (temp. 1050-1150 deg. fahr.) the octane number may be as high as 100.

Recent work in the reforming of straight-run gasoline has added much to our knowledge of the factors affecting the octane number. LeRoi and Ferguson,[4] with a modified tank and tube equipment, report that the octane number increases as the stocks were cracked for greater and greater yields of gas and smaller yields of gasoline. Approximately degradations for their experiments are as follows:

Stock	A.P.I.	Per Cent decrease in yield of total liquid distillate per increase of one in Octane Number	Type of Operation
Straight-Run Naphtha..	51	0.37	Once Through Coil alone or Coal & Soaker
Cracked Naphtha.....	45	0.68	Once Through
Cracked Naphtha.....	45	1.3	Recycling

As an example: If a straight-run naphtha has an octane number of 35 and it is cracked in a once-through cracking equipment, the octane number of an 80 per cent yield of total distillate will be:

$$(100 - 80)/0.37 + 35 = 89$$

or for a 90 per cent yield—

$$10/0.37 + 35 = 62.$$

Yields are seldom less than 80 per cent of total distillate (a loss of 20 per cent). However, these experimenters fail to

[2]Ind. Eng. Ch. 22; 1237, 1930.
[3]The Pet. Eng., p. 104, Midyear, 1930.
[4]"Developments in Reforming Practice . . . " third Midyear Meeting A.P.I., Tulsa, May, 1933.

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report the exact operation conditions for each test and differences in temperature may have had much to do with increases in the octane number. In fact, Egloff and Nelson[5] show no change in octane number of the gasoline produced from Smackover fuel oil although the yield was increased from 39 to 63 per cent by cracking more and more severely. They maintained constant conditions of temperature and pressure in all runs but in other ways their runs are not comparable with those above, particularly because they measured the octane number of the gasoline only and not of the entire liquid product.

The effect of pressure appears to be largely an indirect effect. Obviously, if a gas oil can be completely vaporized at 880 deg. fahr. at atmospheric pressure, a cracking process operating at these conditions will produce gas oil as the major cracked product. The gas oil will be immediately vaporized and leave the system before much cracking can occur. Of course, the vapor may be further heated and cracked before leaving the system but a very long cracking zone must be provided if sufficient time is to be had for producing commercial gasoline yields. In a liquid phase system, the pressure must be increased if gas oil or recycle stocks are to be retained in the system and allow gasoline alone to be vaporized. Pressure also increases the density of vapors and hence allows the time element in a particular equipment to be greater.

The effect of this longer time element due to pressure may be illustrated by the data of Keith et al[6] and reference[4], which shows increases of yield at higher pressures. These increases are probably due to the increased time element rather than the direct effect of pressure. Gas losses are also higher at lower pressures. Sakhanov and Tilicheev[7] report gas losses two or three times as large at a pressure of 10 atmospheres as at 100 atmospheres. Keith shows three times as much gas loss at 100-lb. as at 1000-lb. pressure. At higher pressures the amount of unsaturates in the gasoline is decreased and the amount of naphthenes is increased,[7] resulting in a lower octane-number gasoline.

At cracking temperatures of 800 to 900 deg. fahr. the amount of pressure determines whether the process occurs in the vapor or the liquid phase. Above 900 deg. fahr. the cracking always takes place largely in the vapor phases because the critical temperature of most cracking stocks is about 900 deg. fahrenheit. Cracking becomes noticeable above a temperature of 680 deg. fahrenheit.[8] In a sense decomposition, or perhaps better say changes in properties, takes place below 680 deg. fahrenheit. These changes are most easily noted in lubricating oil stocks. If untreated stocks are heated to even 400 deg. fahr. in the presence of air, they lose color and if the heating is prolonged a loss in viscosity and specific gravity occurs.

As the temperature is raised to above 680 deg. fahr. the rate of gasoline formation increases rapidly. Leslie and Potthoff[8] report that the rate of cracking doubles for each 22-deg. fahr. increase in cracking temperature between 700 and 800 deg. fahrenheit. The literature was carefully investigated and the data shown in Fig. 1 were found. While the proper method of analysing some of the data was doubtful, nevertheless, a chart of this kind is much more reliable than the guessing or reference to a single set of data, which has been used so frequently. Probably a smooth curve could be drawn through the transition between liquid and vapor phase temperatures if the data were more accurate and complete. Nevertheless, the degrees required to double the rate will probably be different at the same temperatures if the extent of vaporization is not the same in two cases.

The data shown in Fig. 1 may be conveniently used in the following equations:

For either phase — cracking for a constant length of time—

$$C_2 = C_1 \times 2^{(T_2 - T_1/tr)}.$$

For either phase — cracking for a constant yield—

$$V_2 = V_1 \times 2^{(T_1 - T_2/tr)}, \text{ or}$$

$$V_1/2^{(T_2 - T_1/tr)}$$

in which—

C_2 = Yield for a given length of time at temp. T_2
C_1 = Yield for the same length of time at temp. T_1
V_2 = Time for a given yield at temp. T_2
V_1 = Time for the same yield at temp. T_1
tr = No. of deg. to double yield (Fig. 1).

These equations are reliable only through that part of the time-versus-yield (at a constant temperature) curve that is substantially linear. Polymerization begins to be an important factor after a certain length of time or degree of cracking so that such a curve begins to flatten and finally longer times result in even lower yields. A more complete discussion of these factors will be found in the second article of this series.

Under these conditions the above equations are no longer valid. Fortunately the extent of cracking in the liquid and vapor phases is usually limited to about 25 per cent and 15 per cent per pass, respectively, and the equations are reliable throughout this range.

The rate at which gasoline is produced by cracking is vitally dependent upon the characteristics of the charging stock. Sakhanov and Tilicheev[9] present the following data, showing the effect of the

Stock	Boiling Range °C.	Specific Gravity 60/60	% of 392°F. distillate
Kerosene	220–270	.81	14.9
Gas Oil	270–300	.834	15.8
Solar Oil	300–325	.859	17.6
Engine Oil	higher	.91	22.4

[5]"Cracking Light and Heavy Oils," third Midyear Meeting, A.P.I., Tulsa, May, 1933.
[6]"The Cracking of M. C. Gas Oil . . . " third Midyear Meeting A.P.I., Tulsa, May, 1933.
[7]Oil and Gas Journal, p. 46, November 28, 1929.
[8]Leslie and Potthoff, Ind. Eng. Ch., 18:776, 1926.
[9]J. Inst. Pet. Tech. 14:761, 1928.

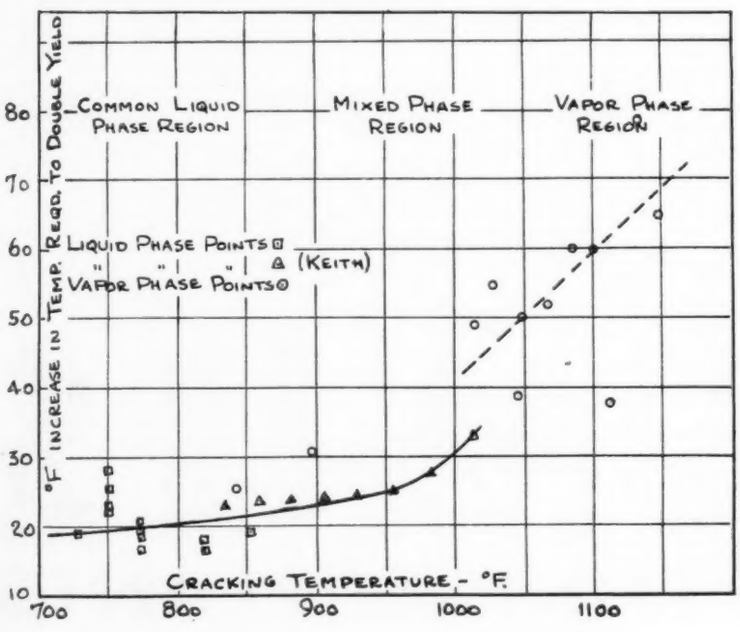

Fig. 1
Rate of cracking with temperature

References:
Sakhanor and Tilichew, Oil & Gas Journal, June 23, 1929; Petroleum, p. 52, 1927.
Watermann and Perguin, J.I.P. Tech., 11:36, 1925.
Geniesse and Reuter, Ind. Eng. Chemistry, 24:219, 1932.
Osterstromm and Wagner, Refiner, December, 1929.
Leslie and Potthoff.[8]
Keith, Ward and Rubin.[6]

charging stock upon the yields obtained in 64 minutes at a cracking temperature of 792 deg. fahrenheit.

The characteristics of the cracking stock can hardly be neglected in attempting to get a comparison of the rate of cracking from different experiments. Such a comparison is shown in Fig. 2, but other factors than the characteristics of the charging stock, or inaccuracies in the data, seem to have affected the results, since no direct relation between gravities or types of oil is apparent. Of course, these data were reported by different investigators and in widely different equipments so that a perfect agreement of data is hardly to be expected.

The data of each experimenter were corrected for comparison to the temperature of 900 deg. fahr., either by the use of Fig. 1 or by data presented by the authors themselves for their particular stocks. The data of Watermann and Perquin were for paraffin wax and perhaps this explains the longer time required for this stock. The data of Keith et al, which are the most extensive data on this subject, are plotted as three sets of curves for 100-lb., 200-lb. and 750-lb. pressure. The influence of pressure as indicated by these curves may not be significant inasmuch as the time at the cracking temperature is dependent upon the computed volumes at these elevated temperatures. Thus the difference in time for the three pressures may be due to errors in the method of computing the volume.

Recycle stocks are more difficult to crack than straight-run stocks. The following table indicates the refractive nature of these stocks. The figures refer to the ratio of the yield from the cycle stock to the yield from fresh stock if the two are cracked under the same conditions of time, temperature and pressure.

Once Cracked	Twice Cracked	Current Recycling	Thrice Cracked	Reference
.6	.318	.....	.175	1
.79	.....	.....	.....	1
.795	.69	.....	.....	10
.....	.....	.4-.47	.....	8

Regardless of recycle ratio the recycle stock from any of the commercial cracking processes will consist almost entirely of once- and twice-cracked material. Thus a currently recycling stock will crack about as readily as twice-cracked stock or about half as readily as straight-run fuel.

Little can be said regarding the amount of heat required for the cracking reaction. Theoretical methods of computing the heat of decomposition, and several of these are available, all fail because the fundamental data required in applying these methods are not available. Nevertheless, all these methods indicate clearly that if large amounts of gas are produced the heat of decomposition is relatively high and if a process can be operated so that no gas is produced the cracking reaction will generate heat rather than require the addition of heat. They also show that the heat of decomposition is higher for heavy fuel oils than for gas-oil or naphtha stocks.

Table 2 indicates the magnitude of the heat of decomposition expressed as B.t.u. required per lb. of 437-EP. gasoline produced. The values shown in the table are all for normal stocks undergoing an amount of decomposition such as occurs in commercial practice.

TABLE 2

Reference	Heat of Decomp. B.t.u./lb. gaso.	Method of Determination
Leslie & Pothoff[3]	900	Laboratory measurements
Obryadchikov & Velikanov[11]	604	Heat Balance of Commer. Unit
" "	630	" " " " "
" "	657	" " " " "
The Author (unpublished data)	615	" " " " "
" "	765	" " " " "
" "	637	" " " " "
" "	740	" " " " "
" "	752	" " " " "
" "	520	" " " " "

[11]Neftyanoye Khozyaistro, Ind. Eng. Ch. 17:370, 1929, and C. A. 24:1206, 1930.

Obrayachikov[12] has outlined one of the theoretical methods of computation. The method is rigorously exact from a theory standpoint, but in application it is not exact because the heats of combustion of the stocks and products cannot be easily determined with accuracy and even slight errors in them may cause the computed heat of decomposition to be in error by over 50 per cent. However, many generalizations can be determined by this method. As an example, Table 3 illustrates the change in the heat of decomposition with the extent of cracking. The first column indicates the percentage of cracked gasoline produced per pass and the second column the average heat of decomposition during the extent of cracking.

[12]Refiner, p. 34, January, 1932.

TABLE 3

Yield	B.t.u. per lb. of gasoline produced
5	2700
10	1710
15	1170
20	900
25	865
35	790

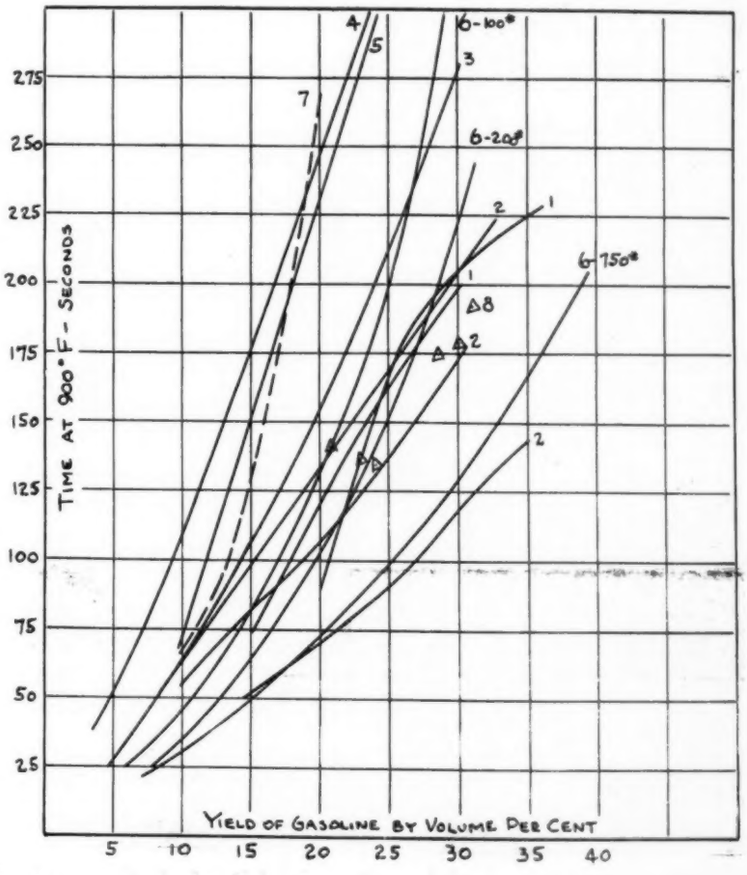

Fig. 2

Rate of cracking with time at 900° F.

Curve No.		E.P. of Gaso.
1	Sakhanov and Tilicheeve, Oil & Gas Journal, p. 48, Dec. 19, 1929	392° F.
2	Sakhanov and Tilicheev, Oil & Gas Journal, p. 44, June 23, 1929	392° F.
3	Cross Bulletin No. 25, p. 287	437° F.
4	Watermann and Perquin, J.I. Pet. Tech., 11:36, 1925	428° F.
5	Leslie and Potthoff[3]	437° F.
6	Keith, Ward and Rubin,[6] Average of Data	400° F.
7	Geniesse and Reuter, Ind. Eng. Ch., 24:219, 1932	437° F.
8	Δ Points—Analysis of plant data by Author	437° F.

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Wildcat Drilling Often Makes Unusual Demands

By K. C. SCLATER

One of the greatest obstacles may be the element of time

FREQUENTLY the factor of time enters into the drilling of deep wildcat wells in isolated regions and gives rise to many baffling situations, besides those ordinarily encountered in drilling. Not only has the well to be drilled to a certain depth in strange formations about which little or nothing is known, but it must be drilled within a certain time limit that leaves no allowance for delays of any kind. Those in charge of drilling the well have to exercise the most extreme care in order to forestall possible difficulties and the equipment used must be able to stand unusual demands of service. A test well that is typical of conditions often encountered under such circumstances was recently drilled in West Texas.

This well is the Todd No. 1, near Barnhart, and is on a large unit block of acreage owned by several major companies and of which the Stanolind Oil and Gas Company is the operator. Some of the important leases in the unit had an expiration date that demanded that no time be lost if a test well were to be drilled before this date expired. Accordingly, when a decision was made in June of last year to start the well, every means of saving time was adopted in order to expedite the work of drilling and complete the test well within the required time limit.

While the rotary equipment was being assembled and a water supply for the rotary rig was being obtained, the 24-in. hole was spudded in with the largest spudding machine available, a medium-sized Wichita Falls spudder. With the exception of some little difficulty encountered in handling the heavy 24-in. bit, the hole for the conductor pipe was successfully completed with this machine and 91 ft. of 20-in. casing set and cemented to the surface.

After the conductor pipe was set drilling was resumed and the hole carried to a further depth with the spudder. At a depth of 370 ft. a subterranean cavern was encountered, which at the well had a vertical dimension of 13 feet. All the water wells in the immediate vicinity had encountered this subsurface void at approximately the same depth. In a survey of the hole preparatory to cementing the cavity the electric light upon entering the cavity encountered an air current that swung the bulb out of view, thus indicating that the cavity was of some extent. By using broken rock and quick-setting cement the cavity was successfully cemented in stages, after which drilling was resumed with no further trouble.

The steel derrick was erected on heavy concrete blocks that extended to a depth of 4 ft. into the caliche. The derrick itself was a Lee C. Moore of tubular steel, 136 ft. high, 26-ft. base, with a rated A.P.I. capacity of 523,000 lb. and with relegs, a total capacity of 823,000 pounds. As no steel derrick framing sills were used the derrick rested directly on the corner concrete foundations. An especially designed steel supporting sub-structure was installed, however. The rotary table girders, of 24-in., 95-lb. I-beam, were carried on top of four 15-in. pipe columns set in each corner of the 22-ft. cellar.

Provisions were made for carrying the set-back of 6000 ft. of 6⅝-in. 25-lb. drill pipe with tool joints, by the installation of tubular supporting columns set in concrete. The steel framing sills of the sub-structure had their bearing directly on the corner concrete blocks. As constructed, the steel sub-structure had a maximum bearing capacity of 1,000,000 pounds. Wooden cushion blocks on top of the supporting beams were used to dampen out the vibrations of the rotary table. It was observed that throughout the drilling of the 8000 ft. of hole the steel sub-structure supported the set-back of heavy drill pipe without any noticeable deflection.

A shortage of water for drilling occurred shortly after rotary drilling was started and it became necessary to switch to electric power for drilling. The steam equipment on the well consisted of a 12-in. by 12-in. Gumbo Buster duplex drilling engine, a 15-in. by 7¾-in. by 20-in. Oilwell pump and a 15-in. by 7¾-in. by 18-in. Lucey mud pump. This was supplemented by a Union Tool 7¼-in. by 14-in. electric pump driven through a Texrope by a 200-hp. variable speed, 400-volt motor. An Emsco drawworks, with 8-in. drum shaft, 7½-in. line shaft, and 7½-in. jack shaft, and equipped with Link-Belt rotary sprocket chain, was connected through a driving chain to two 125-hp. 440-volt 900-r.p.m. drilling motors, using an Ideal twin reduction gear. The steam engine was left in place so that it was a matter of but a few moments to change from steam to electric power for the entire rig. This dual hook-up worked to great advantage in the handling of long strings of casing and in drilling in pyrites with the 3½-in. drill pipe.

A string of grade D (A.P.I.) seamless 9⅝-in. 40-lb. casing, carrying three float collars and a shoe, was landed at a depth of 6124 feet. In cementing this string of casing 1500 sacks of cement were used, and was mixed and pumped into the casing in 39 minutes, using two Halliburton cementing outfits. A pause of 37 seconds was made for switching over to the steam pump, which delivered mud behind the plug in the plug holding device. Only 38 minutes more were required to place this cement behind the casing. The two steam pumps were equipped with compounding connections, to be used in case of necessity. It was not found necessary to compound the pumps, however, as the maximum pressure necessary for placing the cement plug was 1500 lb., which was applied without difficulty with one pump. As ten hours were necessary for running in the casing, the complete job of running, landing and cementing the casing took less than a 12-hour tower.

The last string of pipe set was 7-in. 30-lb. grade D seamless casing, which was landed at 6993 ft. and cemented with 500 sacks of cement. In this cementing job 15 minutes were required for mixing and 22 minutes more to pump the cement behind the casing.

After the string of 7-in. casing was set the hole was tested and found dry, indicating that a secure cement job had been obtained. Drilling was thereafter continued to 8041 ft., at which depth sulphur water was struck. The hole was plugged back to 300 ft. for further drilling out and testing.

The lease on which this well was drilled is at present being held by a producing well in a shallow pay sand.

Repressuring The Southeastern Illinois Oilfield

By MILLARD H. FLOOD
Ohio Oil Company, Robinson, Illinois

Results to date indicate that yield of oil can be increased by repressuring

THE Southeastern Illinois oil field is located on the La Salle anticline, which extends from the vicinity of Oregon past La Salle, south and east through St. Francisville on the Wabash River, and on into Indiana. Oil and gas were first discovered in 1865 near Casey, Clark County, Illinois, but development of the field did not begin until 1904, when important discoveries were made. Drilling continued in this area at a rapid pace until 1908-1909, when the peak of development was reached and operations extended into Crawford and Lawrence counties. Later development has increased the size of the producing area, which today lies mainly in Clark, Crawford, Lawrence and Wabash counties. Most wells have been drilled in Crawford County, although Lawrence County is the most prolific in oil production.

Oil is produced from sands in the Pennsylvanian and the Mississippian. The richest horizons developed are the Kirkwood and the McClosky sands, both of Mississippian age. All the oil-bearing sands are interbedded with impervious shale. They are generally lenticular, with marked local variation in thickness, but there are some "sheet sands" of wide extent. From north to south the more important producing horizons are:

1. The Westfield Lime, found at depth of 300 ft. to 400 ft., and the Martinsville sand, found at a depth of 450 ft. to 550 ft., both in the Lower Mississippian.
2. The Siggins, Casey, and Partlow sands, found productive in Clark County at a depth of 300 ft. to 600 ft. These are in the Pennsylvanian.
3. The Robinson sand, found in the Pennsylvanian at a depth of 900 ft to 1000 ft., and productive in Crawford County.
4. The Bridgeport sand (Pennsylvanian), the Buchanan, Kirkwood and Tracy sands (Upper Missisippian), and the McClosky sand (Lower Mississippian), all productive in Lawrence County and found at a depth of 700 ft. to 1800 feet.

Experimental work was started in Crawford County on the Robinson sand about ten years ago to determine the feasibility of repressuring the various producing sands in the field. Progress was very slow and was not apparent until just recently. At present there is four per cent of the producing area in three counties being repressured by either gas or air, or a combination of both. Recent statistical data on repressuring operations in the Southeastern Illinois oil field published by the Illinois State Geological Survey[1] states:

"Repressuring has been tried on more than 107 leases in the Southeastern Illinois oil field, of which 77 have yielded

[1] "Preliminary summary of results obtained from a survey of repressuring operations in the Southeastern Illinois Oil Feld," by Alfred H. Bell and Frederick Squires. Illinois State Geological Survey Press Bulletin Series, Illinois Petroleum No. 23, September 24, 1932.

Above: Metering gas from an offset producing well, back pressure on which is controlled by fluid level

Left: Portable compressor connected up for making a repressuring test

increased production for one year or more. The repressured leases have a total area of 11,049 acres, of which it is estimated that 3488 acres have been affected by repressuring. This represents only about 3.6 per cent of the total productive area of the field. Out of the 3488 acres increases in production for one year or more were obtained on 2548 acres, or 75 per cent. The total number of input wells was 126, of which 93 were on leases that yielded increased production. Out of 613 pumping wells which were affected, 458 wells, or 75 per cent, yielded increased production."

All present available machinery and equipment, including gasoline plants that had been abandoned, are utilized and improvised for repressuring operations.

For experimental repressuring work a portable direct-connected engine-driven compressor mounted on wheels is used for compressing the injected gas or, where available, high-pressure gas from a near-by gasoline plant may be used.

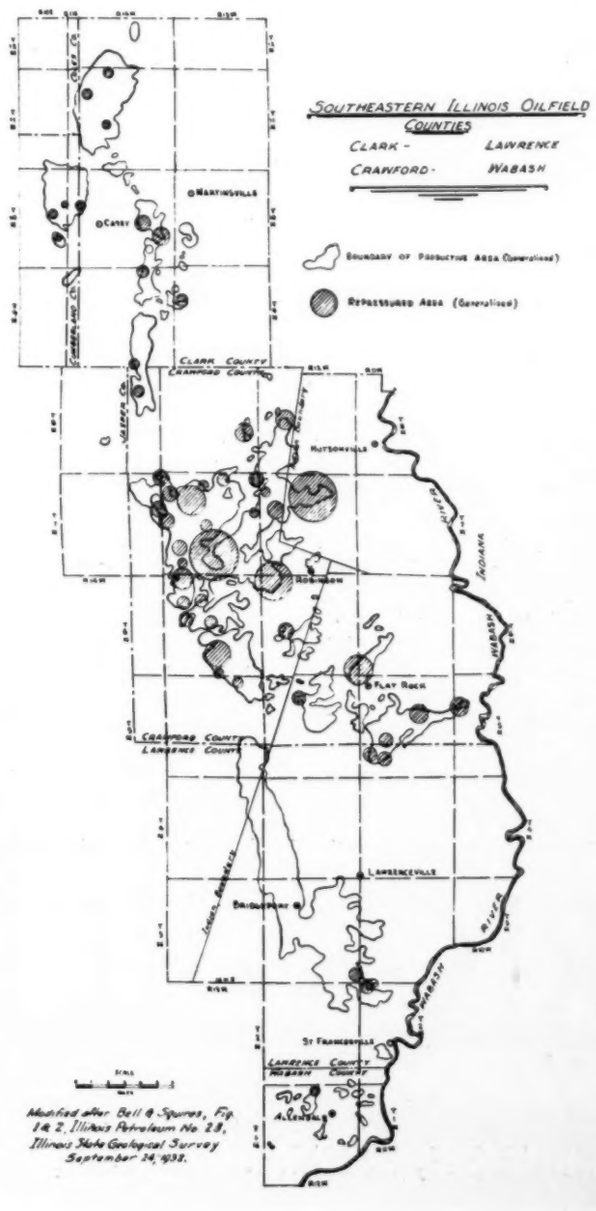
Thus far, experiments made in repressuring the Westfield Lime north of Casey in Clark County have failed to show any increase in production. Owing to dissipation of pressure through joints and fissures it was found impossible in some cases to build up a pressure on the key well. In other cases high pressures were built up in the key well with no discernible effect on the offset producing wells.

Several repressuring tests made in the Siggins pool gave negative results, and the failure to increase production is thought to be due to the general physical character of the producing sand. Because of the presence of interbedded shales in the producing horizon, there is a lack of continuity that is detrimental to repressuring operations.

Fairly good results are being obtained in several small repressuring projects that are in progress southeast of Casey, Ill., in the Casey sand, and farther south, on the axis of the anticline, there are several repressuring plants in operation that are yielding remarkable results in repressuring other producing horizons.

In the Robinson pool, repressuring operations have been carried on to a greater extent than elsewhere in the whole area and with more satisfactory results. Repressuring operations in this pool yield the greatest increase in recovery of any in the entire field.

To the southeast of the Robinson pool in the Flat Rock area some repressuring tests with air and gas have been made but with somewhat disappointing results. Within the area where the tests were made there is a "thief" or depleted gas sand that is believed to have been responsible for the poor results obtained. These tests, however, do not condemn the repressuring possibilities of the Flat Rock area. By a proper choice of key wells and a more thorough study of well conditions it is quite probable that successful results can be obtained.



Although there has been very little experimentation or actual work carried on in Lawrence County on repressuring it is believed by many of the operators that there are many areas that are very favorable for repressuring and that would respond to properly controlled injection of gas or air. Tests started by the writer as well as others in the field, have had to be discontinued for the present because of proration of oil production in the pools of this county.

Most of the producing wells in the field are pumped by jack from central powers. Vacuum pumping has not been used extensively and when used, then only in conjunction with small gasoline plants.

Although there is no uniformity in the size of casing with which the wells have been completed, one commendable feature is that with few exceptions a good water shut-off has been obtained. Where there is doubt about the condition of the casing it is customary to set a packer on the tubing of key wells.

Owing to the presence of hydrogen sulphide and its related compounds in the gas, oil, and water, corrosion of equipment is one of the difficult problems that operators have to contend with in the field, especially, too, in repressuring operations.

Great possibilities can be expected from this field in increasing production by repressuring and it is expected that later, when conditions in the oil industry improve, much of this work will be undertaken. It is certain that in the shallow producing areas of this field some type of rejuvenation will be necessary, and doubtlessly will be tried out on an extensive scale when the occasion demands. It is also the hope of the producers of Southeastern Illinois, that with the cooperation of the Illinois State Geological Survey in experimental work, repressuring operations will increase the yield of oil from the field and be productive of more substantial returns on their investment.

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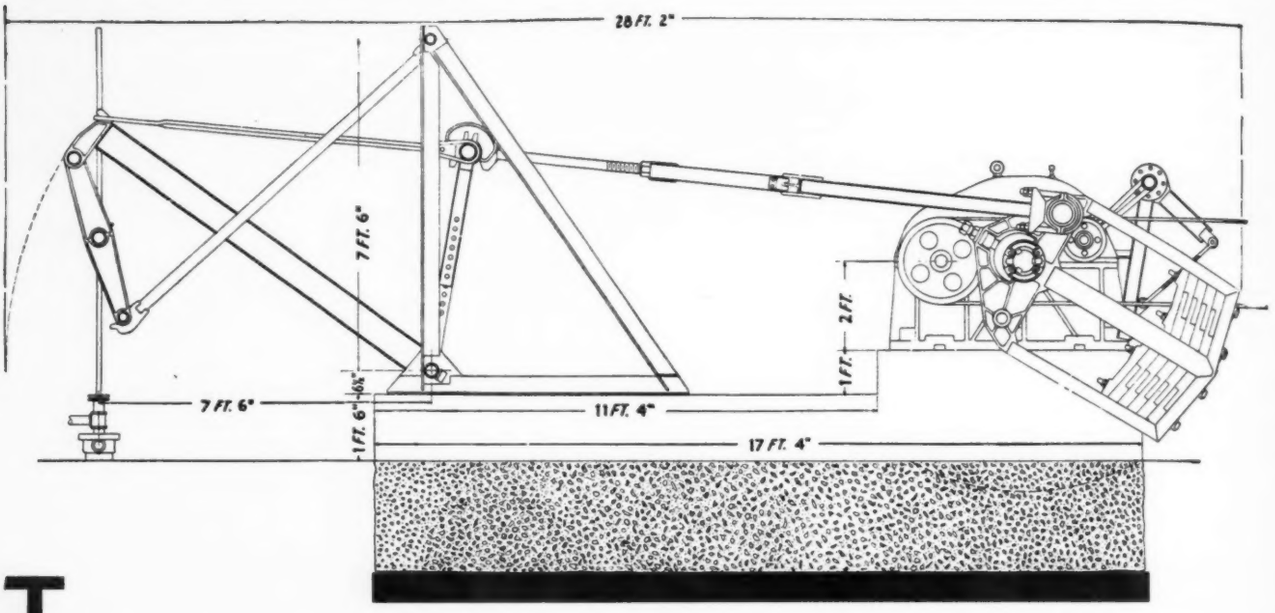

THE design and construction of this Jack is such that an almost straight lift is obtained, the deviation from vertical motion being less than ½ of 1%. The starting of lift is slow and easy. A positive bottom stop prevents rod load being dropped on the stuffing box. Perfect rigidity —jack will not wabble or crawl. Adjustment of stroke is easily made. A 60" stroke is recommended, 72" being the maximum stroke. The removal of 2 bolts and loosening of connecting rod, permits the jack to be moved out of the way so that a 6 foot clearance around well head is obtained for pulling of rods or other operations. Lubrication is by means of large grease reservoirs fitted with Alemite fittings. All frames are electric welded and all castings are made of high grade electric steel except the bearing shells, nut and bushing retainers which are of bronze. Weight 2300 pounds.

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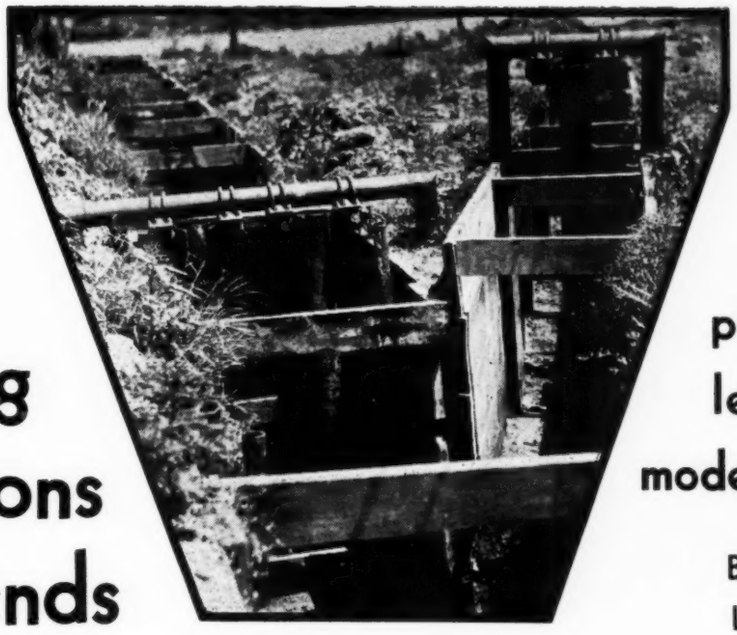
East Texas Pumping Conditions and Trends



Variety of complex pumping problems requires modern equipment

By WARREN L. BAKER

Fig. 1. Pull-rod lines laid 4 ft. beneath surface elevation

East Texas pumping problems continue to hold the limelight in the production division of the industry. As announced, we present on the following pages up-to-the-minute information on methods and equipment actually used in or adaptable to this area. Since new problems are arising daily we shall in our August issue again feature the subject of East Texas pumping.

EAST TEXAS pumping conditions at this early stage are not such as to cause many operating difficulties, but it is thought that wells in the field will ultimately encounter a number of complex problems when production becomes more settled and the wells have become heavy pumpers.

Present Pumping Problems

At this time, the fluid level in the hole is high and there is sufficient gas in solution to assist materially in lifting the oil from practically all the wells; also water encroachment has not reached a point where it is extremely troublesome. Thus, the majority of wells now dependent upon pumping equipment to make their allowable production are light pumpers.

The fluid level in many wells not capable of flowing is sufficiently high to cause the oil to stand within a few hundred feet of the surface. Many of these wells need only to be agitated to bring about a resumption of flow until they are again shut in to keep them within the proration allowable. Agitation with swabbing and pumping equipment are methods employed on wells of this type. The majority of wells now pumping can make their daily allowable within a few hours' time; later it will be necessary for these wells to be operated continuously and not until then will severe service demands be imposed upon pumping equipment. Even for a time after the wells are operating steadily loads will continue to be light, as enough gas will have remained in solution to aid in lifting the oil and to maintain fairly high fluid levels.

Gas-oil ratios in the field have been consistently low. It is an interesting fact that they have not shown any marked change since the field was brought in. Original gas-oil ratios averaged approximately 350 cu. ft. per barrel, and at the present time this average probably does not exceed 375 cu. ft. per barrel. The fact that the gas is in solution in the oil is responsible for this uniformity. However, it is anticipated that gas-oil ratios will increase in the near future, for bottom-hole pressures are declining rapidly and the gas will in all probability come out of solution before the bottom-hole pressure has dropped to 800 pounds.

Today, the most important pumping problems confronting production men are the selection of suitable equipment and its proper installation; the development of economic pumping methods and the adoption of ways and means of operating efficiently under proration orders.

Selection of Pumping Equipment. The selection of proper pumping equipment is not an easy task because of the wide variety of conditions encountered. On the west side of the field, for example, there is a porous sand condition and it is here that most of the water encroachment has occurred thus far; while on the east side, the sand is usually thin and tight and the wells do not have so high a fluid level. In the center strip of the field the sand is fairly porous and quite thick before the water level is reached.

The topography of the area is another factor that operators must consider in purchasing equipment needs. The East Texas field comprises a region whose surface is composed of low rolling hills and numerous creeks. In some sections the topography is so rugged and broken that it is not feasible to use central powers because of the difficulty of installing and the impossibility of obtaining efficient operation of pull-rod lines. Individual pumping units are being used in these districts. Where central powers are installed numerous types of swings, multipliers, hold-ups and hold-downs are required. Many new types have recently been placed on the market and improvement made in the older styles, covering a variety of designs for practically any condition. Some very interesting work has been done in the installation of rod line equipment. In one of the accompanying photographs, Fig. 1, may be seen how three pull-rod lines are operating 4 ft. beneath the ground elevation. All these are from the same power and, before reaching the location shown, they pass over the crest of a small hill and then dip downward to the board-lined pit. Many installations of this type have been made and some of the pits are cement lined. Another picture, Fig. 2, shows a

Fig. 2. Topographical conditions caused rod line in foreground to be laid in an indirect course

pumping jack installation in the foreground, from which may be noticed a rod line running at practically right angles to the one operating the jack. Both lines are from the same power. It was necessary, because of the topography, to lay the one running straight across the picture in an indirect course. An idea of the round-about way it reaches its destination can be had from the fact that the rod line from the jack runs direct to the power. Some operators are using multiplying swings to overcome surface conditions. One rod line is run from the power to a swing installed at a desirable location. Two lines are then laid from the swing to separate wells. In this manner two wells may be pumped while only one shackle line is connected to the power. Frequently this is both economical and advantageous.

Because of the varied conditions a wide variety of pumping equipment is being used in East Texas. Standard and improved beam pumping rigs, central powers of both geared and bandwheel type, individual-powered jacks, units of twin-crank (Fig. 3) or single-crank design, two- and three-well back-crank hook-ups, numerous types of pumps (some of which are rodless), gas-lift and intermittent flowing devices. These units are driven by prime movers of all types, including steam, oil, gas and gasoline engines and electric motors. The rating of the prime movers varies from a 10-hp. motor on an individual pumping well to 100-hp. engines on geared central powers. At this time the actual horsepower requirement appears to vary from 10 to 25 hp., depending upon conditions existing at individual wells. The most common type of internal combustion engines are of 40-hp. rating, with those of 50-hp. and 25-hp. rating being next in popularity. The majority of the 25-hp. engines are second-hand, moved in from other fields. The newly purchased engines all have a larger horsepower rating and can be used for pulling and cleaning-out operations. In the long run they may prove more economical than engines rated below 40 hp., especially where they will be subjected to high pulling speeds on heavy wells. A number of the operators installing prime movers of low horsepower realize that future pumping conditions may necessitate larger units, and they are putting in foundation blocks to accommodate any change in size.

The speed and length of stroke of the pumping units vary considerably. The majority of producers prefer a speed of 18 to 24 s.p.m., and stroke lengths of 48 inches. A recently developed individual-powered jack, shown in Fig. 4, is attracting much attention because it introduces a new operating scale for this type of pumping equipment. It is a long-stroke, slow-speed unit capable of strokes up to 10 ft. in length at the rate of 6, 8, 10 or 12 per minute. In design the unit includes features common to beam and jack pumping. It has a sampson post, crank and wrist pin set-up, with four adjustments, like a standard rig, but otherwise resembles an enlarged type of jack. A special polished-rod hanger gives the rods a straight-lift motion. The jack installed in East Texas is located just north of Kilgore on a lease of the Gulf Production Company. This installation has a herringbone gear speed reducer and is powered with a Hercules gasoline engine and a V-belt drive. The jack of the Gulf Production Company has never been operated steadily. It was installed on a dead well, but after running for about

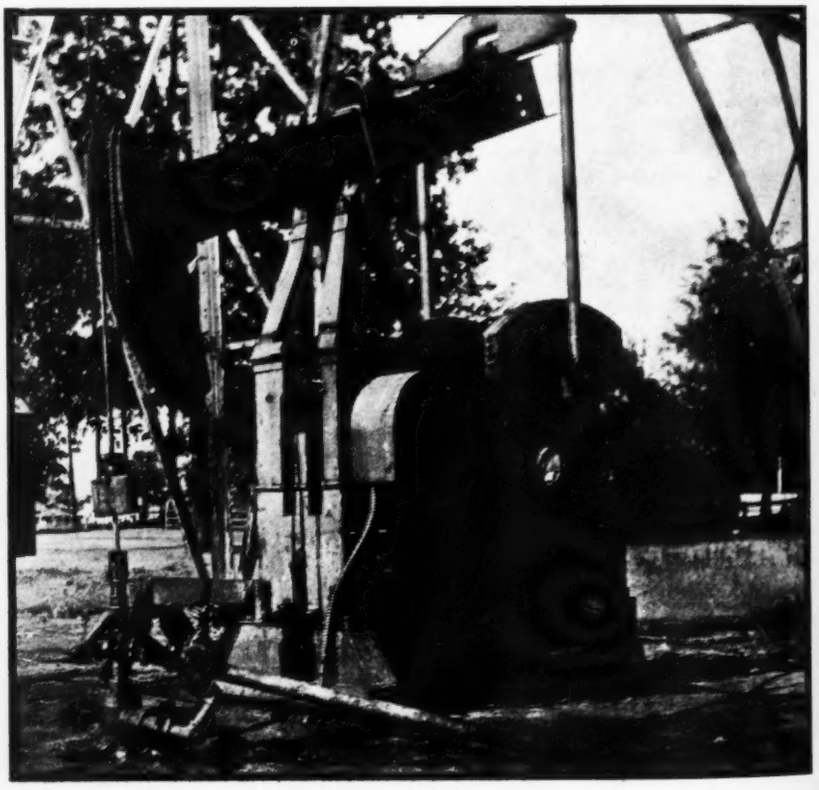


Fig. 3. A twin-crank individual-powered jack installed on a well of Rogers Lacy

30 minutes the resulting agitation was sufficient to cause the well to commence flowing. This operation has been repeated several times. However, a similar jack has been operating successfully in a Gulf Coast field for a year. A number of these units are now being installed in the East Texas field. This week a severe test will be given the unit, when Carl Everett will have one installed on a well near Gladewater producing 1000 bbl. of water per day. The manufacturers, Parkersburg Rig & Reel Company, recommend the unit up to 15 s.p.m., and state that it is capable of withstanding 20 s.p.m. on a two-hour test, a speed which, although unusually severe, may be imposed on the equipment several times when potential gauges are taken.

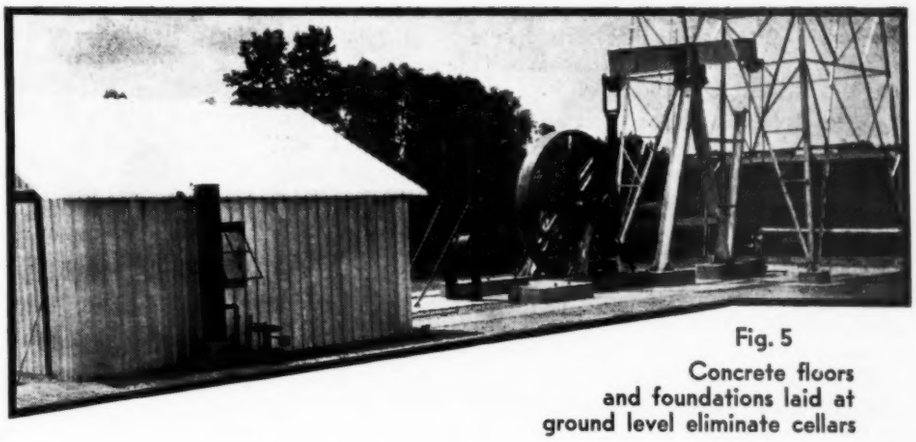


Fig. 5

Concrete floors and foundations laid at ground level eliminate cellars

Installation of Equipment. Some of the most modern and efficient pumping units are being installed in East Texas. Furthermore, some of the construction work is of a high grade that cannot be matched by any other field. During the past several years production men have learned a great deal about the desirability of reducing pumping rig vibration and eliminating fire hazards. In addition to selecting smooth operating machinery, they have found that, when rigidly installed, such installations are steadiest pumpers.

Engineers are depending, to a very large degree, upon concrete for foundations. All engines are being set on concrete and the majority of rigs have a concrete floor set at ground level, eliminating a cellar. A rig of this type is shown in Fig. 5. All machinery is firmly bolted to the concrete. Rigs of this type present not only a very neat appearance but have the added advantage of being fire-proof. The floor is usually sloped to the center from all four corners. In the center of the rig floor is a pit into which all leakage drains, including that from the stuffing box, thus making it possible to keep the location neat and clean. This pit is sloped to one corner, from which a drain pipe carries all waste material away from the location. Many companies are burying all pipes, including flow lines, in the concrete when it is poured. Thus the derrick floor is clear of obstacles.

Again, in the installation of pumping equipment, the topography of the district plays an important role. During the rainy seasons the numerous creeks and rivers become raging torrents and it is necessary that all machinery be placed above the high-water mark, which condition, in some cases, has required concrete foundations 11 ft. in height. During such seasons it is impossible to reach many of the locations with heavy equipment and these sites are being equipped during the summer months. The details of construction being used in installing machinery in the East Texas field have been covered comprehensively in two previous articles[1] in *The Petroleum Engineer* and we need not go into detail here.

Economic Situation. The posted price for East Texas crude oil is a large factor affecting the purchase of pumping equipment for the field. Many operators felt that it was not an economical move to install pumping equipment when the crude produced was selling for 10 cents per bbl., this feeling still persisting somewhat when the price was boosted to 25 cents.

Now that the average price of East Texas oil is almost 75 cents per bbl., many of these operators, the majority of whom are independents, are of the opinion that they will be justified in making expenditures for the purchase and installation of pumping equipment. It is likely that during the next several months a number of those who have been holding back will enter the market and become active buyers of pumping equipment. At the present price level wells can be pumped on a paying basis, hence if crude prices hold and the market becomes firm it is expected to stimulate the buying of pumping equipment.

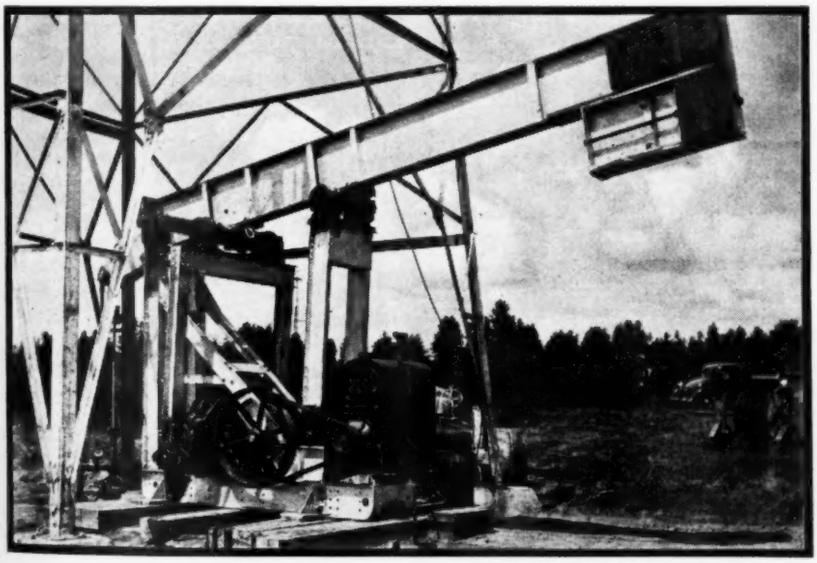


Fig. 4. Long-stroke, slow-speed jack unit capable of strokes up to 10 ft. in length

Proration as it Affects Pumping Conditions. Under the present proration set-up in East Texas there have been frequent changes in the per well allowable. Now, this allowable is based on the well's ability to produce oil and is determined by potential tests made at intervals of several months. The equipment installed must, therefore, be capable of pumping the well at a high rate for a two-hour period during potential tests, and, at the same time, be able to produce efficiently when the well is permitted to make only a fraction of its potential production. Likewise, pro-

[1] "Installation of Pumping Equipment in East Texas," by Dewey T. Ross, *The Petroleum Engineer*, Vol. 4, No. 8, May, 1933.

[1] "Construction and Installation Problems," by Dewey T. Ross, *The Petroleum Engineer*, Vol. 4, No. 10, June, 1933.

ration may not be expected to continue in force during the entire life of the field so that operators must face the problem of selecting equipment for their wells that will handle any demand likely to be placed upon it.

However, some of the operators consider the installation of large pumping units on each well out of proportion to the allowable production; consequently, many large pumping units are being installed with a back-crank (see Fig. 6), to which pull-rod connections may be attached and one or two additional wells pumped by powered jacks from the same prime mover. A pitman connection whereby one or two additional wells may be pumped without the use of a back-crank are also in use, the motion on the pull-rods being obtained from the movement of the pitman wristpins.

These types of hook-ups are very flexible, for, during the light pumping period, the unit investment may be spread over several wells and when the heavy pumping era arrives the inexpensive jack installations may be replaced by large pumping units capable of handling the well load or a prime mover simply applied to each jack.

The rod-line connection from the back-crank may be either 2½-in., 3-in. or 4-in. in diameter and is direct-connected to a hold-down or reducer post, to which is attached the shackle-rod line. Like regular central power installations, each rod-line is passed through a knock-out post. This is an advantage, particularly in East Texas, since the allowable outlet from one well may be produced before the other wells have made their permitted production, and with the use of this type of hook-up the extra wells may be shut down at any time.

While a few companies are using this type of attachment to pump only one extra well, it appears that the best plan is to pump two additional wells and to have them located in opposite directions from the power well so as to obtain a proper balance on the crank of the pumping unit.

Where this type of hook-up is used in conjunction with the standard beam pumpers, the installation is similar, with the exception that the attachment is made at the pitman crank. A few companies have installed what is known as a power deflector, this being a device designed to absorb the vibration shocks set up by unbalanced extra loads and thus prevent racking of the rig.

There are also available two-well jack hook-ups that may be used when one jack is of the individual-powered type. The jack equipped with the prime mover operates the other jack by means of a rod-line running from the rein head of the former to the pull-rod connection on the latter jack. Installations of this kind represent a saving in original cost and in lifting cost. They operate successfully so long as the load is not unusually heavy. The lifting stroke of one jack alternates with the other, the rein head of one jack being in the opposite position from the other, thus distributing the load so as to maintain it uniform on the prime mover.

Since the majority of wells in the field can now make their allowable production within a few hours' time, none of the pumping equipment in the field has been subjected to heavy, continuous operation—a condition that will be imposed on the equipment when production is more settled.

Prospective Pumping Problems

Paraffin and water encroachment are prospective pumping problems of major importance. Some operators are also of the opinion that floating sand will be present when the fluid level becomes very low. These opinions are based partly on the history of other fields producing from the Woodbine sand and on certain knowledge that paraffin and water are in existence in East Texas. These conditions will, naturally, make the wells heavy pumpers and will require pulling operations at frequent intervals. However, it is not implied that these problems will become serious or confront engineers and superintendents at any early date, except in a small degree, but when purchasing lifting equipment it is wise to consider them as probable factors.

Paraffin. Crude oil produced in the East Texas field contains paraffin in solution in the oil at present average bottom-hole temperatures, less than 150 deg. fahrenheit. As the crude reaches the surface, it often deposits wax in the tubing, tanks and pipe lines. In a few instances, it has formed on the face of the pay sand. This problem is not yet an acute one, but, as the field becomes older, it will increase in importance. Indications that paraffin will shortly become a more serious problem are to be found in statements of some operators that more paraffin is noticed now when the atmospheric temperature is high than during the past winter when surface temperatures were much lower. Paraffin has given most trouble thus far in tanks and pipe lines, or surface equipment. However, it has frequently formed deposits in the tubing. There are two ways in use for removing the accumulations from tubing strings, namely, with chemicals or by means of mechanical scrapers.

In one well on the Kilgore Townsite the production had fallen to 25 bbl. per day, after which it would pump off. The sucker rods were logy on the down stroke and the engine was showing signs of carrying a heavy load—the result of paraffin deposits. It was decided to try to dissolve the paraffin with chemicals. Two gallons of Separafine were poured into the stuffing box and permitted to run down in the tubing. As the well was dead this was an easy method of injecting the chemical. After 24 hours, pumping operations were resumed and, for a two-hour period, the well pumped paraffin. This process was repeated every day for

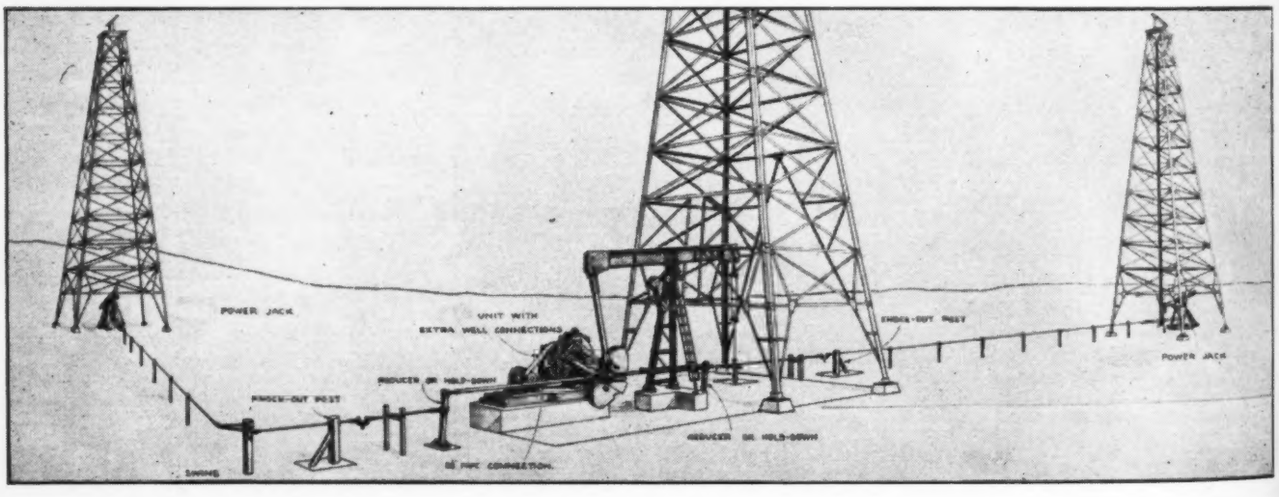


Fig. 6. Diagramatic sketch showing back-crank hook-up for two additional wells

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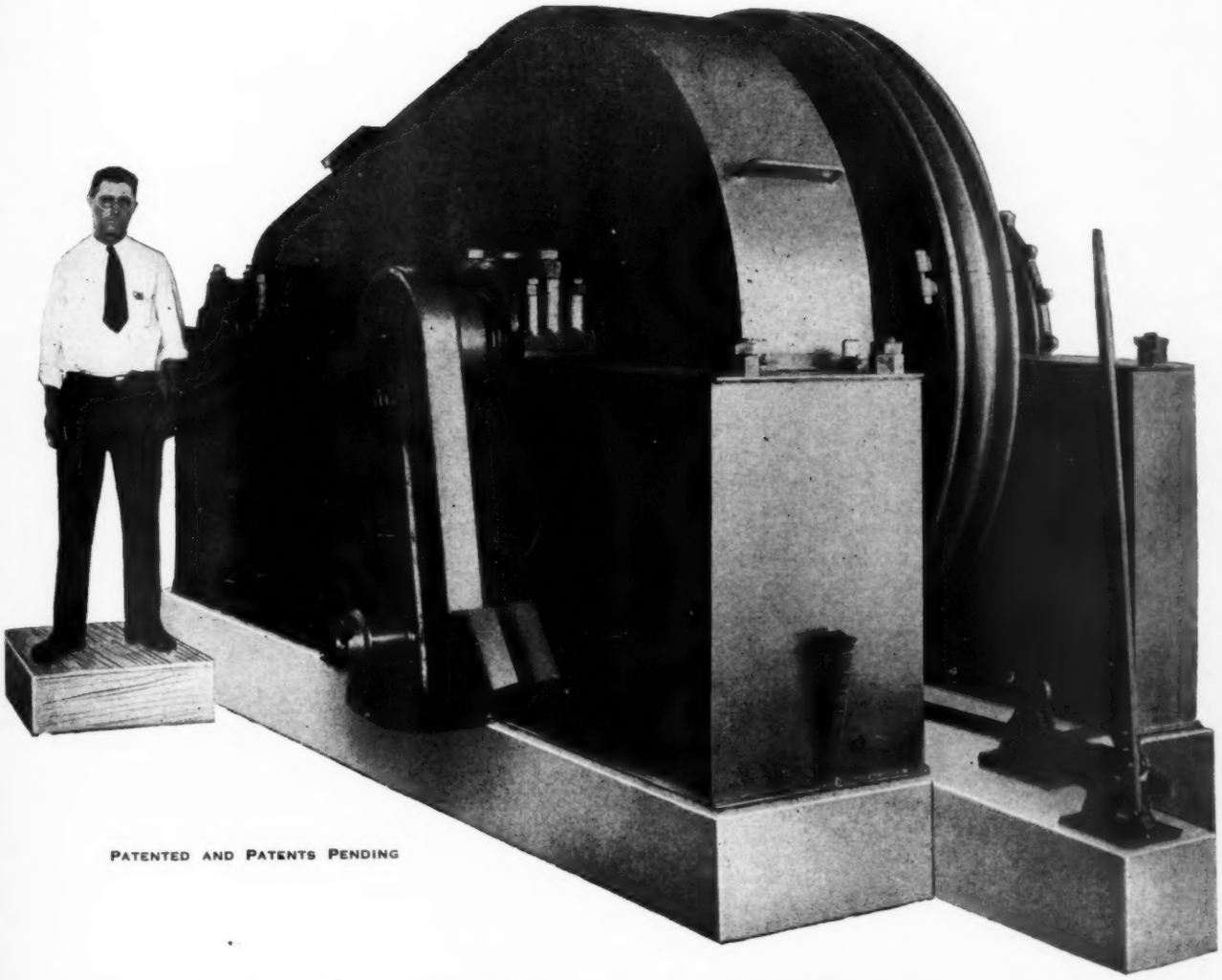

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three days and, at the end of this time, the output from the well had been increased to 35 bbl., more than enough to pay for the cost of the chemical, besides taking the load off the pumping equipment. The tubing is now kept clean by the use of one gallon of chemical per week.

When paraffin scrapers or knives are used for removing paraffin accumulations from the tubing, the device is run into the hole on a sand line. This tool consists, primarily, of a rod to which are attached a number of cutting blades and a sinker of sufficient weight to cause the tool to fall against the normal pressure encountered in a well. The operation of the scraper consists of giving the line a jerking motion in a vertical direction. Since the blades are set at an angle, this produces a rotary motion, thereby completely scraping the walls of the tubing. When the well is pumping, it is necessary to remove the rods and working barrel and bailing is usually resorted to as a means of lifting the wax after it has been freed from the tubing. Despite the fact that many operators are, generally speaking, using production methods that tend to lessen the deposition of paraffin, the formation of bridges in the tubing is becoming increasingly common. Paraffin deposits are usually found from 200 to 1000 ft. from the surface and frequently give trouble in getting back into the hole after the rods have been pulled. The accumulation of paraffin is more noticeable on the east side of the East Texas field than on the west side. In wells on the east side, it is not uncommon for paraffin plugs to be solid for lengths of 200 ft. or more.

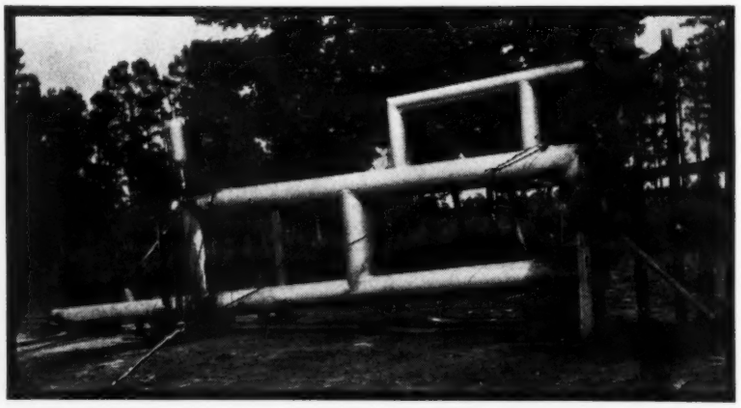
Water Encroachment. While water intrusion in the producing sand has not yet reached a stage where it is a serious problem, except in a few individual instances, it is expected to be one of the major difficulties encountered in pumping East Texas wells. Since the latter part of April many additional wells have commenced to make water. The majority of these are not yet heavy pumpers as the oil fluid level is high and there is yet enough gas in solution to aid in bringing the fluid to the surface. Many wells have continued to flow up to the time the water output has reached 1000 bbl. daily.

Many of the wells making water are handled through automatic water knock-outs, whereby the saline fluid is removed at the flowing pressure of the well before passing the oil and gas through flow beans or chokes, then taking the oil and gas through elevated separators that operate at low pressure. These types of water separators have been very successful in handling the water problem to date but it is likely that some changes will have to be made as the well pressure diminishes and the volume of water becomes larger. Chemicals and the usual gun-barrel type of treating installations are likely to find favor with many operators.

The automatic water knock-outs in use, like other equipment in the field, vary greatly as to type. The Mazda Oil Company has an economical operating automatic type of water separator on its Bell lease, west of Kilgore. Two 4-in. lead lines from the casinghead are swedged into a 12-in. hollow horizontal pipe that acts as an expansion chamber. At the far end of this large pipe, which is about 20 ft. long, a choke has been placed in the crude oil outlet flow line running to the separator. Beneath this connection is an outlet drain for the B.S.

In the same vicinity, another type of knock-out pressure separator is in use by Albert Plummer on his Bell lease. This separator, shown in Fig. 7, consists of a 12½-in. O.D. pipe that rests horizontally on raised supports. Inside the large pipe a joint of 6⅝-in. casing has been placed, through which the gas from the separator is turned and there burned to raise the temperature of the oil, which flows through the annular space between the smaller tubing and the larger pipe. The oil flows through raised vertical and horizontal 6⅝-in. pipes to the outlet (see accompanying photograph). The water drip is at the right-hand side of the picture and it flows horizontally toward the left as shown in the lower portion of the picture. This system permits the heating of the oil to practically any desired temperature and demands very little attention to operate. It has proved an efficient method of handling 25 per cent water emulsions on flows up to 50 bbl. per hour.

Fig. 7. Automatic type of water knockout separator on East Texas well



This unit can treat 25 per cent water emulsion on flow of 50 bbl. hourly

Thus far water has not become troublesome enough that water waste disposal is a major problem, but it is expected that it will in the future. Operators confronted with the problem of disposing of salt water find that running it into evaporation pits is sufficient at the present time, but when greater volumes are produced it is likely that this method will be inadequate and other means will necessarily be sought. There is some talk of providing a huge coöperative partnership disposal system, but as yet no definite plans for its construction have been made.

Conclusion

The East Texas oil field, because of its enormous size, will have pumping problems the variety of which will not be encountered in any other oil field in the world. Many of the complex pumping problems of other fields will be found here, including those arising from paraffin, salt water, and low well pressure. Swampy land and river bottoms will add their share of trouble. The varied types of individual wells make it hard to standardize on any particular design of pumping hook-up, for in the different areas of this 40-mile-long field the selection of the pumping unit will be governed by the local conditions and the kind of operation required. The whims of operating officials of the more than 1000 operators in the field also make for variation in equipment design.

While the problems of pumping East Texas wells will be many and difficult, it may be said that the type of equipment now being installed is of modern, improved design and should give efficient and satisfactory service. The fact that practically all surface machinery, including both individual pumping units and central powers, being installed is laid on concrete foundations is indicative of the advanced knowledge oil field operating men have gained on the advantages of the permanent type of installation and its relation to uninterrupted pumping operations. Installations of this type represent great progress in applying engineering principles and will do much toward eliminating many difficulties in pumping East Texas wells.

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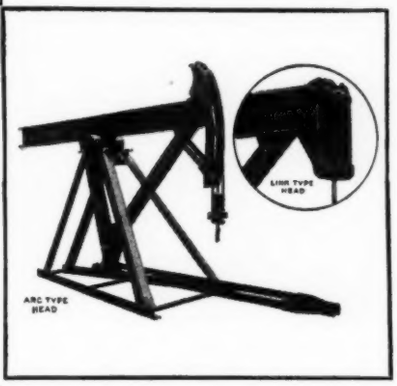

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Many Refinements in Modern Well-Pumping Equipment

MANY improvements or refinements are noticeable in the types of pumping units that are being used in the East Texas field. In fact that field is a veritable proving ground for pumping equipment designed within the past two years. Not since the Greater Seminole, Oklahoma, has a major field been placed on the pump and East Texas operators are the first to be afforded an opportunity of taking advantage of the new equipment.

The increased use of steel and alloy metal and more precise workmanship are important advancements worthy of note. Walking beams of steel construction throughout are finding favor with most East Texas operators. In instances where the bandwheel driven by a belt from the prime mover is being used to impart motion to the walking beam, the steel bandwheel is very popular. The belt drive from the prime mover to the bandwheel is usually conveyed through an improved type of belt tightener that permits ready adjustments over a wide range.

Improvements in design of bearings, provision for proper lubrication and wider use of steel to reduce costs of operating and maintenance

There is a marked tendency to give more thought to proper lubrication of all moving parts. Especial attention is being given to beam design that permits convenient and reliable lubrication of the pitman bearings, saddle bearings and rod hangers. Only good grades of fresh, clean lubricating oil are in regular use. These factors, together with efforts of field men to eliminate dirt so far as possible, are being stressed by many of the operating companies. Noiseless operation is being promoted, friction reduced and appearances improved.

Counterbalancing is almost universally a part of the equipment installed on each well. From field tests made during the past year, particularly in the East Texas field, engineers have learned that correct counterbalancing can be determined more closely by making a thorough check of the well load with a dynamometer, and this sensitive instrument is being widely employed to analyze pumping loads so that proper counterbalancing may be obtained.

Straight-lift motion is being given much study and the units installed thus far are equipped with polished-rod hangers. Because fluid levels are still high, many of the pumping wells head when the rods and tubing are pulled and, in order to reduce the fire hazard, oil savers are being used on a great many wells of this type.

Of particular interest because of the improvements that have been made in their design are the pumping jacks being purchased by East Texas operators. These are sturdily constructed of structural steel for efficient, dependable and trouble-free performance. They are of weather-proof, oil-bath design. Noteworthy improvements have been made in the method of constructing these jacks that permits quick assembly in the field. They are readily adjustable to provide a wide range of polished-rod strokes to suit the individual well conditions.

A well-received jack unit in the field is the twin-crank type, usually individually powered. These have a steel walking beam mounted on a strong structural-steel derrick-type Sampson post. They are oil-bath roller bearing equipped and twin-counterbalanced. The counterbalanced cranks are provided with sufficient pockets or other arrangements in which weights may easily be placed to provide the necessary lag or lead for perfect counterbalancing of an individual well. The twin-crank unit is designed for maximum convenience where severe pumping conditions are encountered.

A big advancement in pumping has been the increasing adoption of slow-speed pumping methods, which in other fields have been found to save power costs and maintenance expense on rig and pumping equipment. By far the majority of standard pumping units installed in East Texas are equipped with speed reduction units.

The most interesting pumping equipment development, however, is the geared type of central power. More than 120 pumping powers of this type have been installed. East Texas is the first field in the world where units of this construction have been used, with the exception of less than half a dozen in other Texas and foreign fields. Full details on this type of equipment were given in the June issue of *The Petroleum Engineer*.

Because of its influence in obtaining trouble-free operation of pumping rigs, the modern lifting equipment being installed and the improved attention and care this machinery is receiving, East Texas is the center of interest for all oil men operating pumping property.

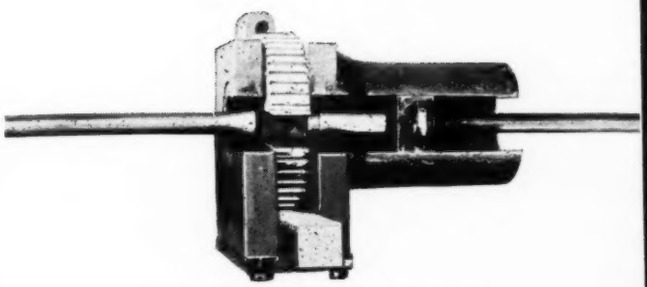

Fig. 1—Mechanical sucker rod wrench

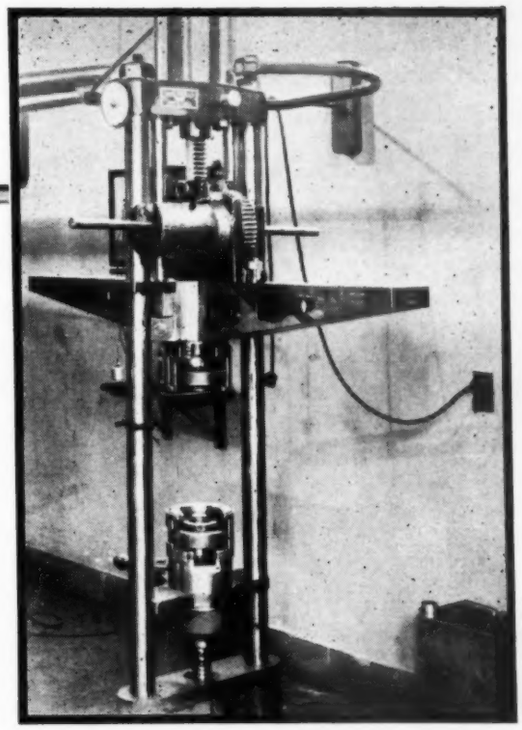

Fig. 2—Mechanical sucker rod wrench in compression machine

An Investigation of the Load in a Sucker Rod Joint

By

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L. W. VOLLMER

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THE desire to increase the life of sucker rod strings has resulted in much time being spent in determining the load in strings, the effect of counterbalance, etc. One important factor, which has received little, if any, attention, is the load placed in the joint when it is made up. The load in the joint when the rods are loaded is also of considerable importance and has not been given the attention it deserves. It is the purpose of this article to describe some tests that were made on sucker rod joints and to discuss the significance of the results.

Reason for Studying Load in Joint

It has been found from an analysis of field data that 25 per cent of the sucker rod failures are pin failures.[1] These failures are due to fatigue and start as a crack, which forms at the root of the last vanishing thread on the pin. It has been shown that the first thread transfers about 40 per cent of the load carried by the pin to the box.[2] This large load on the first thread combined with a high stress concentration factor due to the sharp fillet at the root of the thread is the cause of the fatigue failures that start at the root of the last vanishing thread.

There are several possible methods that can be used to correct or reduce this weakness. Among these are: to obtain a better load distribution along the pin, to use a steel with a higher endurance limit, to change the thread form and decrease the stress concentration, and to reduce if possible the load in the pin. Of these possibilities the latter alone would require no change of material or method of manufacture and would not change the cost. The decrease in load can only be changed by altering make-up conditions. Since this requires only an alteration of field make-up practice it seems that this possibility should be among the first to be investigated. The relation between make-up torque and load in the

[1]Blaine B. Wescott, "Manufacture of Sucker Rods," *Petroleum Engineer*, April, 1931.

[2]Emory Kemler, "An Analysis of Stresses in Sucker Rod Joints," A.S.M.E. Transactions, *Petroleum Mechanical Engineering*, August, 1932.

joint has been analyzed by both theoretical and experimental methods.

Theory

A—Relation Between Initial, Applied, and Total Load in a Joint. When a joint is made up by applying a torque the counterbored part of the box is subjected to compression and the pin is then put in tension. This results in the pin having an initial load. It can be shown that the theoretical relation between the working load in the pin, the initial load and the applied load can be expressed as[2]

$$Q = Po + F\,[1-(Ab/Ap + Ab)]$$

where Q = working load in the pin
Po = initial load in pin
F = applied load or load in rods
Ab = area of box
Ap = area of pin.

For a ¾-in. box:

$$Q = Po + F/2.$$

In making such analysis it is necessary to neglect the flexibility of the threads. For long bolts this causes little error but for such a short compression member as the case of a sucker rod box the error becomes appreciable. The theoretical equation shows that the relation will be of the form

$$Q = Po + C\,F$$

where C is a constant to be determined from experimental data. When the joint opens $Q = F$, then $F = Po + C\,F$, or $F = (1/1 - C)\,Po$. Since we can determine the load at which the joint opens and Po can be measured with a strain gauge, C can be determined from the test results.

Experimental Methods

A—For Determining Torques. A mechanical sucker rod wrench (shown in Fig. 1) was used to measure the torque applied in making up a joint. The load was measured by placing the wrench in a hydraulic testing machine (Fig. 2) so that the torque was applied by running the head of the testing machine down and rotating one part of the joint by the gear to which it was attached. It was found when a joint was made up by applying the load steadily that upon being rapped by a hammer the torque would decrease to as low as 25 to 50 per cent of its original value. This action can be accounted for by the surface irregularities left after the thread cutting operations. Therefore, in order to get consistent results the joints were continually hammered when they were made up.

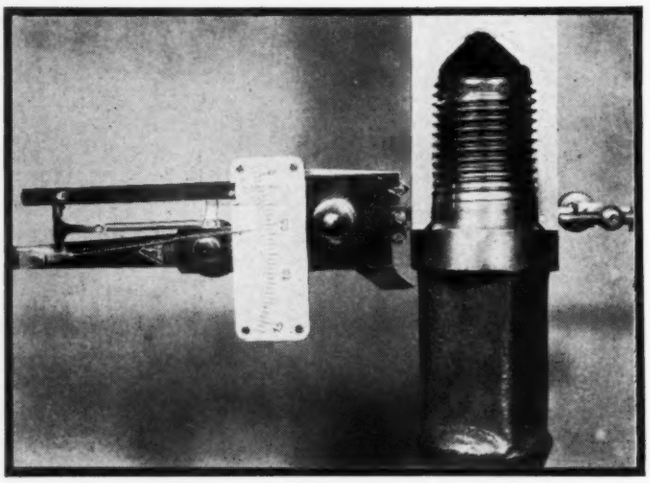


Fig. 3—Huggenberger Tensometer

To determine the torque to open the joint one part of the joint was attached to the gear, which causes the rack to press against the head of the testing machine and the torque applied by a wrench attached to the other part of the joint. The maximum torque applied to the wrench was measured by the testing machine.

B—To Determine Tensile Loads. The determination of the initial load set up in a joint and the load to open the joint require extensometer measurements and, since the compression member of a sucker rod joint is very short it requires a special extensometer to read the strains. A Huggenberger extensometer having a magnification ratio of 1010 to 1 with a special attachment capable of being adjusted for gage lengths from 0.35 in. to 1.00 in., was used to obtain the deformations over the very short gage length that it was essential to employ. This instrument is shown in Fig. 3; the box is cut away to show the position of the strain gage relative to the threads.

After the joints were made up they were placed in the testing machine and the strain gage attached. The load was then applied to the ends of the rods and strain readings taken until the joint opened. The load at which the joint opened was determined by the point at which the strain gage failed to show any change in length of the compression part of the joint, thus signifying that all the compression in the box resulting from the make-up torque had been released.

The initial load in the joint was calculated from the

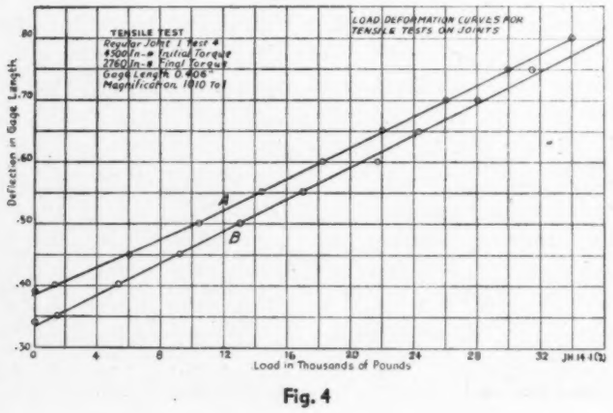


Fig. 4

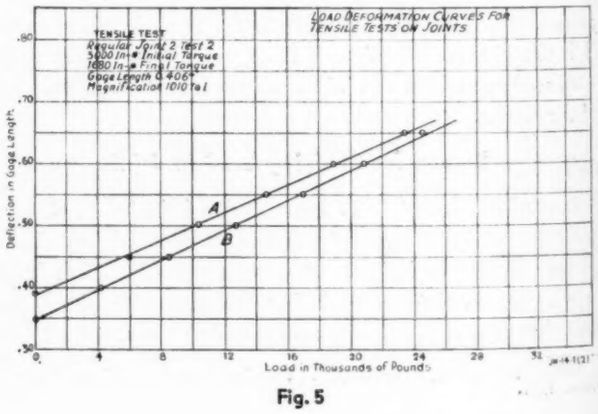
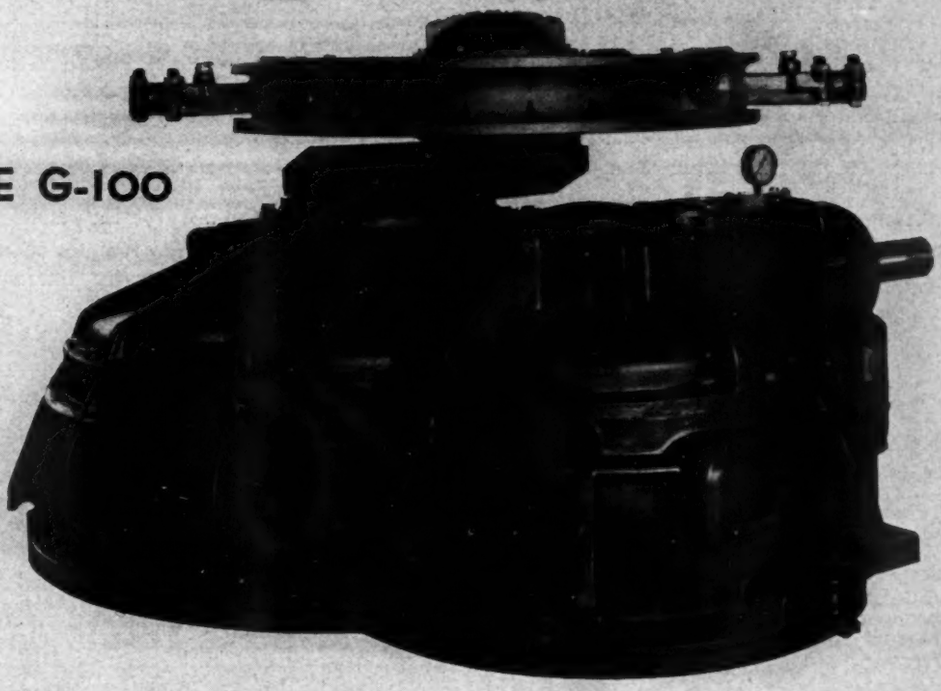


Fig. 5

NATIONAL Pumping Power

TYPE G-100



The Type G-100 Geared Power is a compact, strong, dependable power, capable of handling heavy well loads. The construction provides great strength and rigidity without excess weight.

Gearing has been designed with large diameter, wide-faced pinions, which insures low bearing pressures and efficient oil film lubrication. First reduction is through a set of Gleason carburized alloy steel spiral bevel gears; second reduction is a set of wide-faced single helical gears, generated by National on the Sykes machine. Gearing is entirely enclosed in a rigid housing, dirt-proof and oil tight.

Every bearing in the G-100 Power is a Timken, selected to give a high factor of safety. Extremely rigid mountings have been provided so that correct alignment is maintained at all times.

Correct design, high quality materials and workmanship and continuous, filtered lubrication result in reduced power losses and minimized wear, and insure years of dependable, care free service.

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TABLE I
Summary of Tests on Joints

Test No.	Initial Load (I) lb.	Load to Open Joint (II) lb.	Ratio of II to I	Initial Torque in. lb.	Final Torque in. lb.	Coefficient of Friction (μ)	Experimental Constant (C)
1–1	20,000	22,400	1.12	4500	1905	.187	.107
1–2	19,400	24,000	1.235	3000	1650	.127	.190
1–3	14,800	18,200	1.23	1800	1590	.100	.190
1–4	26,700	34,000	1.27	4500	2760	.124	.213
1–5	15,500	18,800	1.21	1800	1200	.097	.174
2–1	22,600	30,000	1.33	4500	2760	.150	.245
2–2	18,000	25,400	1.41	3000	1680	.138	.290
2–3	19,400	26,400	1.36	4500	2250	.170	.265
2–4	12,900	18,500	1.43	1800	1350	.116	.300
3–1	16,000	17,200	1.075	3000	1800	.154	.070
3–2	25,000	30,000	1.20	Note 1	1200	.100	.166
3–3	28,900	40,000	1.39	Note 2	3510	.114	.280
5–1	19,500	21,600	1.11	3000	1350	.127	.096
5–2	27,700	32,500	1.25	4500	3150	.120	.198

Note 1—This joint was made up with sucker rod wrenches. Joint was in such a position that it could not be given much of a snap.
Note 2—Joint was made up with sucker rod wrench in a position where a good leverage could be obtained.

change in length of the part of the box to which the gage was attached. If e is the elongation of the box in the gage length l (in inches), Ab the area of the box, and E the modulus of elasticity, the initial load in the box is

$$Po = (e/l) \times E \times Ab.$$

Experimental Data

Two typical curves, giving the results of the tensile tests, are shown in Fig. 4 and 5. It was found from these tests that the joint showed different characteristics after it had been opened once. Curve A on each sheet represents the load-deformation relation the first time the joint was opened, curve B represents the load-deformation relation for any time after the first application of the load. This change during the first unseating results from a combination of a change in the seating conditions of the shoulder, a smoothing down of the rough spots in the threads, a change in tension caused by a reduction of the torque and a permanent yielding of the threads caused by their being stressed beyond the elastic limit.

Tests were made on four different joints. Three of these were regular A.P.I. joints taken from stock. The other joint was an A.P.I. joint modified by increasing the depth of the box counterbore to 9/16 inch. This joint was used to determine whether the effect of the vanishing threads had any effect on the deformation of the box. The two tests on this special joint showed that the vanishing threads did not affect the test results.

Table I gives a summary of the results of the tests, the initial load being calculated from the measured deflections of the box. For example, in test 1-4, the results of which are shown in Fig. 4, the elongation in the gage length is equal to $(0.80 - 0.385)/1010 = 0.000408$ in.

$$Po = (e/1) \times E \times Ab - (0.000408/0.406) \times 30 \times 10^6 \times 0.884 = 26{,}700 \text{ lb.}$$

The load at which the joint opens is the point at which there is no further deflection of the gage or is the point at which the curve stops rising. This value is 34,000 lb. for joint 1-4.

In order to determine the relation between the torque to tighten a joint and the torque to open the joint, tests were made at three different initial torques. The summary of these tests is given in Table II. The joints were made up on the mechanical sucker rod wrench and hammered to insure a tight joint. They were then reversed and broken without ever being pulled. The coefficient of friction was calculated from the equations.

$$Tt = Po\ (1.215\theta \times 1.15)$$
$$To = Po\ (1.215\theta - 1.15).$$

When Tt is the torque to tighten and To is the torque to open the joint. The ratio of Tt/To is known so Po cancels out. μ is then $\tan^{-1}\theta$; θ being in degrees in the above equation.

TABLE II
Relation Between Torque to Tighten and Open a Joint

Tightening Torque (in. lb.)	Opening Torque (in. lb.)	% Decrease of Torque	Coefficient of Friction (μ)
4500	3600	20%	.151
3000	2325	22½%	.134
1800	1425	21%	.136

TABLE III
Analysis of Tests on Basis of Initial Torque

Initial Torque (in. lb.)	Average Initial Load (lb.)	Experimental Constant (C)	Average Coefficient of Friction (μ)
4500	24,500	.240	.144
3000	18,100	.160	.136
1800	14,400	.207	.104

1930 1931 1932 1933

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Discussion of Results

The results summarized in Table III show that the value of the constant C varies between 0.20 and 0.25. The value 0.160 seems to be in error, since there is no reason why the particular value of initial torque of 3000 in. lb. should result in such a small value of C. Test 3-3 indicates that the value of the initial torque for tightening a joint in the field is about 4500 in. lb., corresponding to an average initial load of 24,500 lb. The load in the joint for an average ¾-in. A.P.I. joint made up fairly tight with 18-in. wrenches will then be given by the equation

$$Q = 24{,}500 + (1/4)F.$$

The ordinary loads carried by a ¾-in. sucker rod in the top of a string lie between 16,000 lb. maximum and 2000 lb. minimum.

$$Q\ min. = 24{,}500 + (2000/4) = 25{,}000 \text{ lb.}$$
$$Q\ max. = 24{,}500 + (16{,}000/4) = 28{,}500 \text{ lb.}$$

While the load on the rods will vary between 16,000 lb. and 2000 lb. the load in the joint will vary from 28,500 lb. to 25,000 lb. The actual load taken by the joint under these conditions will be 80 per cent greater than the load in the rods.

When made up with 3000 in. lb. torque the equation for the load in the joint would be

$$Q = 18{,}100 + (1/5)F.$$

The value of $C = 0.20$ has been used because it seems reasonable that the value of C should be more or less independent of the torque.

$$Q\ min. = 18{,}100 + (2000/5) = 18{,}500 \text{ lb.}$$
$$Q\ max. = 18{,}100 + (16{,}000/5) = 21{,}300 \text{ lb.}$$

For this amount of initial torque the load in the joint will be 33 per cent greater than the load in the rods.

When made up with only 1800 in. lb. torque there is the following relation: $Q = 14{,}400 + (1/5)F$.

$$Q\ min. = 14{,}400 + 1/5 \times 2000 = 14{,}800 \text{ lb.}$$
$$Q\ max. = 14{,}400 + 1/5 \times 16{,}000 = 17{,}800 \text{ lb.}$$

In this case the load in the pin is only 11 per cent greater than the load in the rods.

Fig. 6 shows that if the make-up torque becomes very large the increase of the load in the pin over the load in the rods becomes very large and may result in a very great decrease in the endurance strength of the joint.

The values of the effective coefficient of friction compare very well with the values given in most text books. The decrease in the value of the coefficient with decreasing torque is probably because the pressures are lower and the lubrication is much more effective.

A comparison of the stresses in the rod and pin is also of interest. For 4500 in. lb. torque the load in the pin will be about 1.8 times the load in the rods. If the load in the rods is 16,000 lb., giving a stress of 32,000 lb./sq. in., the stress in the pin would be

$$(16{,}000 \times 1.8)/\text{area of pin} = 41{,}000 \text{ lb./sq. in.}$$

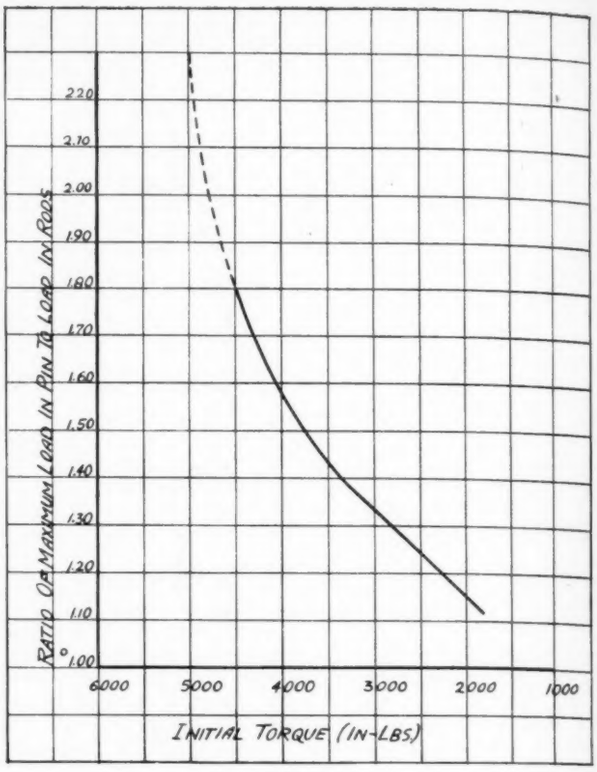

Fig. 6

If there were no stress concentration in the pin because of the notch effect of the threads the stress would be 30 per cent greater than the stress in the rods.

Conclusions

1. The initial load in a joint is an important factor in determining the working load carried by the joint.

2. The working load, Q, carried by a joint is given by

$$Q = Po + (1/4)F$$

where Po is the initial load in the pin caused by tightening and F is the load in the rods.

3. The stress in the pin will be much higher than the stress in the rods if a high torque is used in making up the joint.

4. There may be some changes in a joint after being subjected to a pulsating load.

5. One factor that will influence the endurance strength of the joint will be the range as well as the magnitude of the stress carried by it.

6. The coefficients of friction found from the tests correspond closely to those given in most text books.

EDITOR'S NOTE: This article is really the fifth in a series on sucker rods started in the April, 1931, issue of *The Petroleum Engineer*. For handy reference here is the list of the articles in this series already published; others will be added from time to time:

"Sucker Rods—Modern Methods of Manufacture," *The Petroleum Engineer*, p. 74, April, 1931.

"Sucker Rods—A.P.I. Specifications," *The Petroleum Engineer*, p. 86, May, 1931.

"Sucker Rods—Their Care and Use," *The Petroleum Engineer*, p. 52, September, 1931.

"Sucker Rods—Why They Break," *The Petroleum Engineer*, p. 26, November, 1931.

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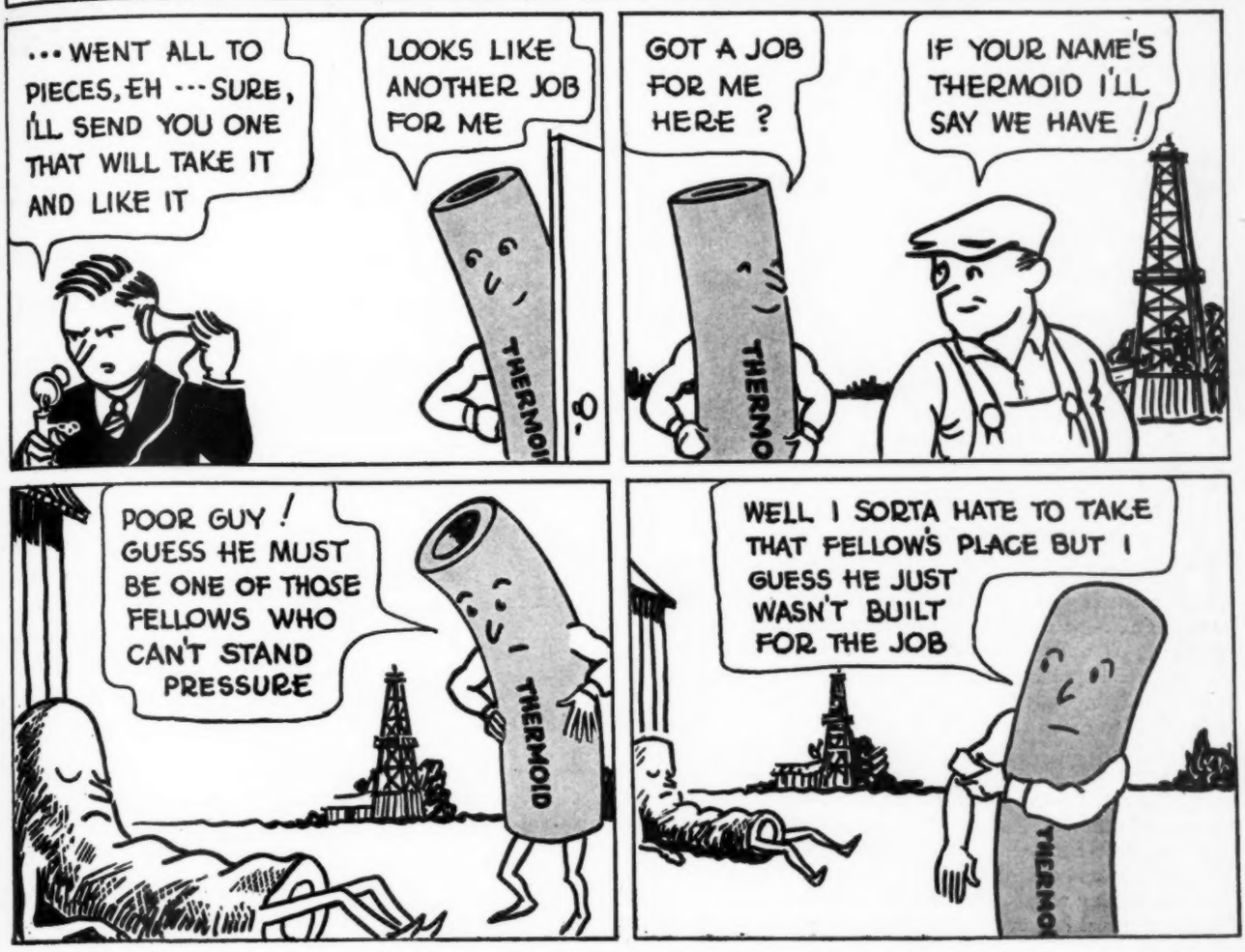
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GOT A JOB FOR ME HERE ?
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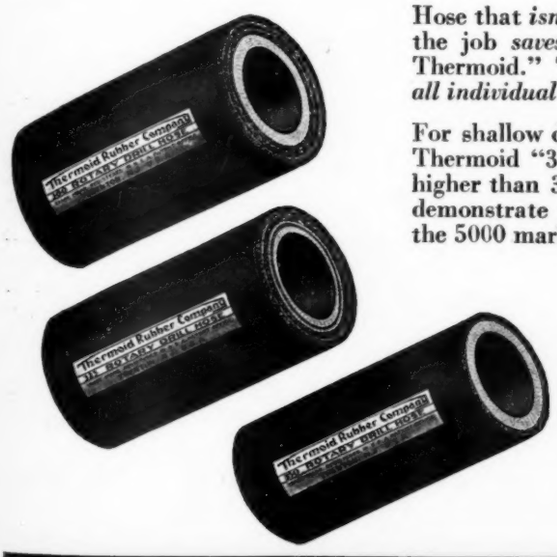
THERMO
POOR GUY ! GUESS HE MUST BE ONE OF THOSE FELLOWS WHO CAN'T STAND PRESSURE
THERMOID
WELL I SORTA HATE TO TAKE THAT FELLOW'S PLACE BUT I GUESS HE JUST WASN'T BUILT FOR THE JOB
THERMO



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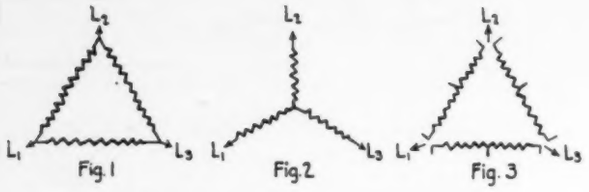


Fig. 1

Fig. 2

Fig. 3

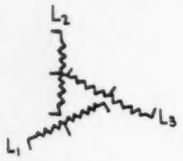


Fig. 4

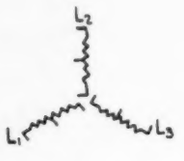


Fig. 5

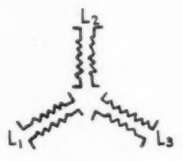


Fig. 6

Fig. 7

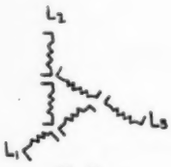


Fig. 8

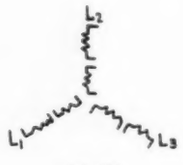


Fig. 9

DURING the last year or two the attention of equipment engineers has been directed to the possibilities of using single-speed multiple-rated squirrel-cage motors for pumping oil wells. Fundamentally a multiple-rated motor is not a special type but is merely a standard motor with additional leads brought out from the stator winding so that it is possible to group the conductors externally into more than one combination. The idea is not new, as a double-rated motor known as the Delta-Star has been in use for pumping and servicing wells for a number of years. Such motors can be converted into one having three ratings at a nominal cost and no great expense is involved in providing an auxiliary switch that makes it possible to utilize the different ratings without having to go to the trouble of reconnecting the leads at the terminal box every time a change occurs in the power requirements.

Basically, the stator winding of a three-phase motor consists of three groups of coils, each of which covers one-third of the stator iron. In the older types of motors these groups are connected within the motor in Delta as in Fig. 1, or in Star as in Fig. 2. Since the cost of a motor designed for a Delta connection is greater than that for one of the same capacity designed to be connected in Star, motor prices are usually based on the latter. A motor that has its normal rating when connected in Delta will carry only one-third of this load when it is connected in Star. This reduction is due to the decrease in the voltage over each phase that results when the windings are grouped in Star. It is evident from Figs. 1 and 2 that a double-rated motor can be made by bringing out six leads from the winding of any standard motor, providing it is designed for normal operation with the Delta connection.

One method of obtaining three ratings is to bring out a tap from the middle of each of the phase windings in addition to the six regular leads, when a winding is so designed that this can be done. The groupings are shown in Figs. 3, 4 and 5 and the ratings will be in the proportion of 25, 16, 9, or 40, 25, 15 horsepower. The exact values chosen for the intermediate and lowest ratings are somewhat arbitrary.

Four ratings can be obtained by bringing out 12 leads and using the grouping shown in Figs. 6, 7, 8 and 9. The ratings will be in the proportion of 25, 18, 12 and 7 hp., respectively. Evidently the connections in Figs. 7, 8 and 9 are equivalent to those indicated in Figs. 3, 4 and 5, and the ratios of the motor capacities are the same.

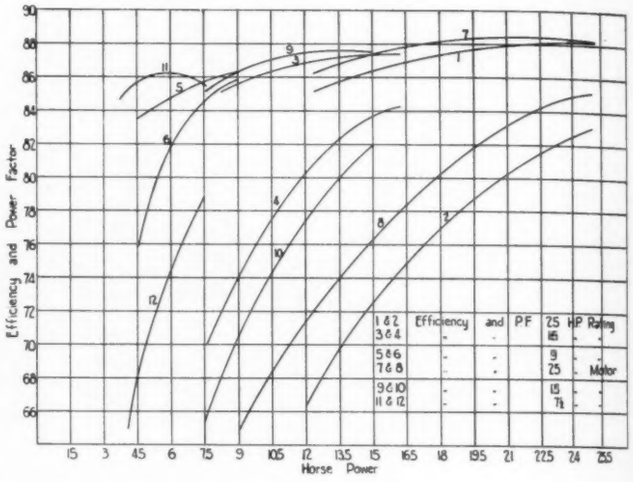


Fig. 10

It is interesting to note that all the changes outlined above are equivalent to varying the voltage over a motor. The rating of a motor subjected to a voltage below that for which it is designed is proportional to the square of the voltage, so that a 25-hp. 440-volt motor assumes the characteristics of the 16-hp. motor above when a voltage of 352 is impressed over it. Likewise, a 40-hp. 440-volt motor has the characteristics of a 10-hp. motor when operated on a 220-volt circuit.

The advantages of an installation of multiple-rated motors over one consisting of motors having a single rating are as follows:

(1) Each well will be equipped so that it is possible to handle the heaviest load that may develop.

(2) Potentials can be taken, after which a connection for a lower rating can be used.

(3) It makes possible the standardization of motors, only one frame size being used. This simplifies the stocking of replacement parts.

(4) It is possible to operate a well at all times on a connection that will give a higher efficiency and power factor than will exist when a single-rated motor is used on all loads.

Single-Speed Squirrel-Cage Motors

By W. C. LANE
Electrical Engineer

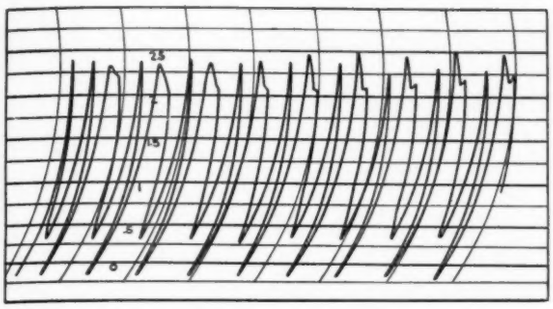


Fig. 11—Scale ½—Power consumption of pumping well with 5-hp. motor

(5) A motor can be switched to a high rating for starting the load and then thrown over to one of a lower capacity for pumping.

(6) The energy demand will be reduced.

In connection with advantage (4), reference is made to curves in Fig. 10. These show the efficiency and power factor of a 25/16/9-hp. motor and of three standard motors rated at 25, 15 and 7½ hp., respectively. The values plotted are the average of the guarantees given by the three major electrical manufacturing companies. The efficiency of the 16-hp. connection is better than that of the 25-hp. motor below a load of 14 hp., but not so good as that of the standard 15-hp. motor. There is much more difference in the power factor. The 9-hp. rating gives a much higher efficiency and power factor than does the 25-hp. motor on small loads. The 9-hp. and 16-hp. motors are less efficient than standard motors rated at 7½ hp. and 15 hp., respectively.

One thing the curves on the 25/16/9-hp. motor show is that it is good practice to drop the voltage below normal on motors that are carrying less than their full load. The prevalent practice of operating 440-volt pumping motors at 480 volts decreases the power factor and increases losses.

Claims for high efficiency and power factor of pumping motors do not mean so much in practice as might appear on first consideration. The values shown on the curves in Fig. 10 are for a constant load. Figs. 11 and 12 show the actual loads on two pumping wells, Fig. 13 the kw.-load on a transformer bank carrying 11 such wells, and Fig. 14 the current taken by the group. Believe it or not, the 11 motors get in and out of step like a group of clocks on a watchmaker's bench; at times they fall out of step and appear to drive one another, some acting as generators and others as motors. It is evident that the efficiency and power factor of loads that vary in the manner shown are indefinite and elusive quantities. Not a few graphical measuring instruments on the market refuse to measure such loads accurately, or at least they do not check when connected in series for metering any such loads as those shown in Figs. 11 and 12.

A high power factor on an induction motor is dependent on several things, but usually it is associated with one of two factors or a combination of both—a small air gap or an excessive amount of material in proportion to the rating as in the case of the 9-hp. connection. Since perhaps 75 per cent of the trouble on a settled installation consisting of a large number of pumping motors is caused by bearing trouble and dragging rotors, only motors having an ample air gap should be used regardless of the possible lower power factor. The higher the efficiency of a motor and the better its speed regulation, the greater the power and current fluctuations will be and as far as motors are concerned, fly wheels have virtue only when used with those having a bad speed regulation.

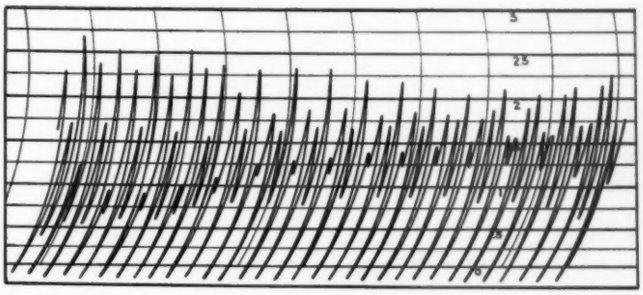


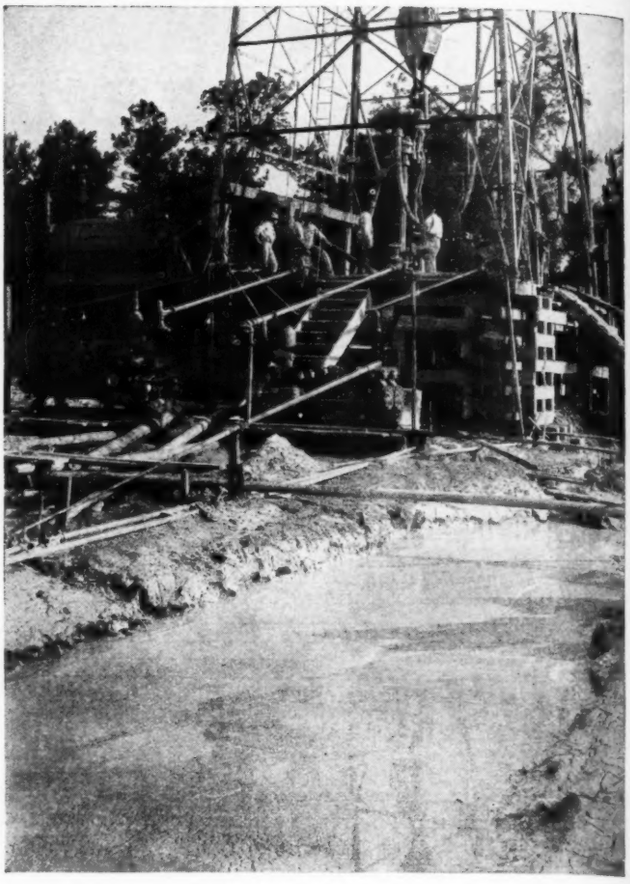
Fig. 12—Scale ¼—Power consumption of pumping well with 10-hp. motor

The rating of a motor required to pump a well is always limited by the amount of heat it can dissipate and not by the actual load it will turn over. Since the heat generated by the load is proportional to the square of the current it follows that the integral of the values of the current squared of such loads as are shown in Figs. 11 and 12 is a much larger quantity than the average value of the current squared. The multiple-rated motor should run cooler on its lower ratings than a single-rated motor of equal capacity by reason of its greater bulk and cooling facilities. It seems reasonable to think that the current variations on the lower ratings will be greater since the resistance of the motor windings is comparatively lower.

In general, a motor that will pump a given well will start it if it is properly counterbalanced. It has been observed that production men who live with the wells are inclined to operate motors on the higher ratings if the speed can be kept normal, regardless of what the engineer has recommended. Since the multiple-rated motor operates at practically the same speed on all ratings, it is not hard to surmise that its use may encourage carelessness in counterbalancing and, as a consequence, an increase in the power demand. Small purchasers of electric power should not expect demand charges to be based on the lower ratings, since the motors are such that they can be changed to a higher rating by simply throwing

In addition to giving you heavier mud

COLOX *won't settle out in the ditches or ball up in the well;*



neither will it ball up when you jet it with water; *it wets easier.*

I've pumped in a lot of Colox and I know.

Colox has helped us get jobs done that would have given a lot of trouble from high pressures, caving, etc.

Colox Will Do This: Carry cuttings from bit at greatest speed
Makes thin pumpable mud up to 18 lbs. per gallon
Makes a thin strong filter cake on the walls of the well
Lets gas and cuttings separate out quicker . . . Acts as lubrication agent in the hole; reducing power consumption and wear on equipment.

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Helpful Information on Drilling Fluids along with *why* Colox gives better results is contained in this booklet . . . We'll be glad to send it to you.

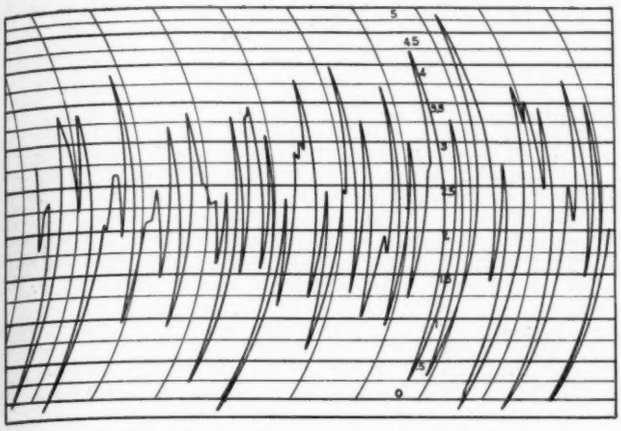


Fig. 13—Scale 1/10—Power consumption of eleven wells with 5-hp. motors

an invisible switch, or changing the connection of concealed leads.

In the long run much less trouble will be experienced if, when the motors are first installed, switches be provided that make it possible for all the ratings to be obtained simply by the operation of a lever that can be locked in any position desired. A motor arranged to give three or four ratings is such that its connections should not be tampered with by average run of electricians when it is necessary to change the rating. Should the markings on the terminals of a motor having 9 or 12 leads be removed, it will be found that there are numerous possible connections, the majority of which are wrong. For example, there are 66 possible connections of Fig. 7. Maximum economy will be obtained when it is possible for the field man to plug in on the circuit with an ammeter and by switching the motor from one rating to another, determine which connection takes the minimum current. A check can be made on the counterbalancing of the well at the same time. Experience has shown that the real test comes after the engineers have folded up their blue prints and returned to the office. It is the writer's belief that after an installation has once been made, its operation should be so simple that when motor trouble does come the average field electrician and a roustabout can change a motor in the night by lantern light.

In the past it has been the custom to equip all wells in a given area for competitive pumping. The cost of drilling and equipping a well was paid out of the flush production, after which it was a battle for barrels. Engineers were told that the loss of a day's production would pay for the heavier equipment and few would risk recommending anything else. This was the line of least resistance and fortunately profits were made in spite of much useless buying. The use of the multiple-rated motor is based on the old theory, which dictates that each well is to be equipped with heavier equipment than is needed for the average working conditions. This in itself is not a large item were it not customary to purchase other oversize equipment in order to have a balanced pumping unit.

The use of an installation of this kind is justified in fields where the quantity of fluid to be handled is likely to vary over a wide range within a short period of time. Such conditions may arise where a heavy producing field is put under proration and potentials are established by pumping, in fields not prorated that have a high initial production and a rapid decline, in fields where much water is encountered, and in fields in which proration breaks down or does not exist and the law of the jungle is in force. It is probable that a small company with only a few wells will derive more benefit from the use of multiple-rated motors than will a large company that has facilities for switching motors from rig to rig as horsepower demands change.

The wells controlled by a large producing company in a given area rarely ever reach the same stage of production simultaneously. Their power demands are such that possibly three sizes of motors can be used to advantage. It appears that for conditions other than those outlined in the preceding paragraph, the use of two or three different sizes of standard motors with characteristics similar to those shown in Fig. 10 is the better practice. Universal foundations on which the different motor frames may be set make it possible to move

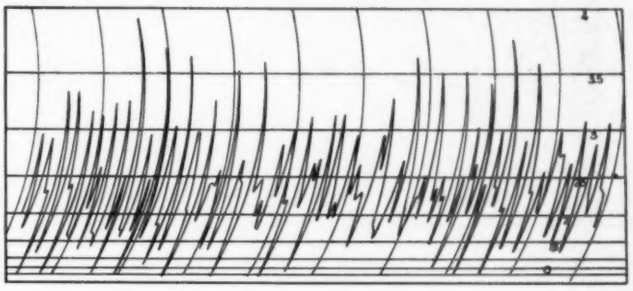


Fig. 14—Scale 1/20—Current consumption eleven wells with 5-hp. motors

motors from well to well as needed. It is frequently found that a surprisingly small percentage of the total number of wells in an installation actually require large motors.

The advantage of being able to purchase motors from the open stock of any electrical manufacturing company should not be taken lightly. Multiple-rated motors are special stock and as such, are a source of grief both to the user and the manufacturer. As far as the special motors are concerned, their first cost is about five per cent greater than that of a single-rated standard motor. The auxiliary switching equipment necessary to obtain the flexibility recommended herein will amount to possibly 15 per cent of the cost of the bare motor with which it is to be used. This is in addition to the standard line starter and cut-out in common use.

Referring to the probabilities regarding the use of each rating, it is difficult to arrive at any definite conclusion. On a large installation of several hundred wells, with which the writer was associated several years ago, the different sizes of the single-rated motors used were distributed approximately as follows:

Size:	A	B	C	D	Total
Per Cent Installed -	3½	2½	20	74	100%

The sizes in the table bear about the same ratio to one another as do the ratings of the quadruple motor mentioned. Before the property was electrified it was the opinion of practically all the production men in the field that motors of size A should be used on all wells. Edge water was known to exist and it was reasonable to think that a water drive was in progress. In the end the field did not behave according to the text books and no trouble was experienced in handling the work with the lighter equipment.

It appears to the writer that the basic idea of the multiple-rated motor is sound, but like every other good thing, it should be applied only after a careful analysis has been made of the conditions that may arise during the life of an oil field.

Pipe Used in Laying First Oil Line Is Still in Service

ALTHOUGH many miles of it have been removed from the original location, much of the pipe used in constructing the world's first oil pipe line is still in service. In 1891 the idea of a double pipe line, one for crude and another for refined oil, originated with Lewis Emery, Jr., of Bradford, Pa. His object was to lower expenses and at the same time improve upon facilities for transporting petroleum from the oil regions to points along the seaboard.

Despite the fact that announcement of his intention to build such pipe lines was looked upon as a joke, in 1892, the United States Pipe Line Company was organized and actual construction of the lines was begun the same year. Because of many obstacles encountered it was not until 1901 that the project was finally completed. Two separate lines of wrought-iron pipe were laid, a 4-in. line to handle crude oil and a 5-in. diameter carrier to transport refined products. The two lines were laid parallel to each other for the entire distance of 378 miles from Bradford to Marcus Hook, Pa.

The lines practically crossed the State of Pennsylvania from the northwestern corner to the southeastern. They traversed 16 counties and 6 major rivers. The lines were therefore subjected to a variety of soil conditions in addition to severe climatic changes common to that latitude. All pipe in the lines was uncoated wrought-iron and practically no corrosion trouble was experienced. It is interesting that the lines were operated at an average pressure of 1000 lb. up to the very day of dismantling for shipment elsewhere and that, although more than 30 years have passed since the lines were first laid, most of the pipe is still in use for one purpose or another.

Samples of each of the old lines were obtained and an analysis shows the wrought-iron to be of the following chemical composition:

	C	Mn	P	S	Si	Cu	Slag
4-in. line -	.044	.059	.157	.014	.235	Nil	3.23
5-in. line -	.030	.030	.245	.023	.160	.054	3.38

The use of pipe lines as a factor in transporting refined oil successfully was originally discredited by many oil men, but the feasibility of this method was demonstrated with the highly successful operation of the U. S. pipe line system.

In 1913 the pumping of crude oil was discontinued by the company. The 4-in. line was cleaned and converted into a refined oil line and connected at Titusville with a line leading from Oil City. It was then used exclusively for handling standard white oil, which had prior to this time, under the rigid inspection of the oil inspector, been handled through the 5-in. water-white line. The handling of these two grades of oil (vastly different in color, gravity and fire-test factor) was made possible only by exercising great care against the slightest admixture of the two oils. While no elaborate system of gauges was required, yet the position of the different blocks of oil in the line and their arrival at the various stations was computed with mathematical exactness.

The liquidation of the United States Pipe Line Company was started in 1923 and the last of the lines was taken up in the summer of 1925. After the pipe was uncovered the lines were disjointed, cleaned and inspected. As the material was sold each joint was again gone over by the inspectors.

After 30 years of service the pipe was still in excellent condition. Some sections were pitted, but the pits were shallow and well distributed. Of the 295 miles of 4-in. and 238 lines of 5-in. removed between Bradford and Freemansburg there were only two carloads rejected. These rejections included all bent and crooked pipe from under-passes and directional changes in the line.

Much of the pipe was sold to the Pure Oil Company, with the Magnolia Petroleum Company and a second-hand dealer purchasing the remainder. The second-hand dealer later resold most of his share to operators in the Ohio-Pennsylvania fields and it is still in service.

The 5-in. line from Oil City to Titusville to Warren was sold in the ground to the Pure Oil Company. It was operated by them until 1927, when it was sold to the National Transit Company, which company is still using it.

The section of both lines from Warren to Bradford to Eldred was purchased by the United Refining Company and is still in service carrying crude oil to Warren at a pressure of 790 lb. for the 4-in. line and 560 lb. for the 5-in. carrier.

The pipe of both lines in the section from Eldred to Freemansburg and the 4-in. line only from Freemansburg to Marcus Hook was removed from the ground and sold. The Pure Oil Company used this pipe in constructing a line from Yahola to Drumright, Okla., and for a line near Bald Hill, Okla. The old 5-in. line from Freemansburg to Marcus Hook is being used by the Pure Oil Company for transporting fuel oil to Freemansburg. Approximately 112 miles each of the 4-in. and 5-in. was sold to the Magnolia Petroleum Company and installed in a pipe line in Oklahoma.

General Purpose Photo-electric Relay

An improved general purpose photo-electric relay, designated as type CR7505-A4, has been announced by the General Electric Company, Schenectady, N. Y. Outstanding among the characteristics of the improved relay is the convenience with which adjustments can be made. The adjustment knob, which formerly was located at one side of the tube socket, has been placed, in a prominent position, on the bracket that supports the tube. This alteration affords easy access to the knob when adjustments are to be made. The earlier models were designed so that it was necessary to change the wiring connections to cause the relay to function upon the admittance of light when it was wired to operate upon the exclusion of light. A single-pole, double-throw snap switch now eliminates any wiring changes. With the switch in one position, the relay will function when light is admitted, and when the switch has been thrown to the other position, the relay will only operate when the light source has been cut off.

The adjustment screw of the sensitive relay, which was located underneath the upper part of the enclosing case in some of the earlier types, is now easily accesible inasmuch as the relay has been mounted in a horizontal position and the screw located conveniently.

The improved relay, closely resembling type CR7505-A3, its immediate predecessor, provides the same sensitive control and likewise operates at a minimum light intensity of three foot-candles. The relay utilizes the Pliotron tube, specially designed for industrial purposes, the improved phototube housing with a cast aluminum base and drawn aluminum hood, and also flexible armored cable between the phototube and relay proper. These features were originally announced in connection with the CR7505-A3 relay.

The improved relay has a wide variety of industrial applications, including the operation of magnetic counters, the control of mechanisms, and the starting and stopping of machinery.

Hot Rolled Seamless Steel Boiler Tubes

Jones & Laughlin Steel Corporation of Pittsburgh has announced a complete line of hot rolled seamless steel boiler tubes. A push-bench mill, the only one of its kind in this country, is used for manufacture. The forging action of this mill is claimed to be excellent, the quality of the steel being improved with each step in the process.

These J. & L. boiler tubes have exceptional ductility and lend themselves quite readily to rolling in and beading operations. A striking characteristic of J. & L. boiler tubes is their striking appearance, the surfaces both inside and outside being unusually smooth. This, the manufacturer states, is an important factor in retarding corrosion when the tubes are in use and in minimizing depreciation while they are held in stock.

The product complies with the A. S. M. E. Boiler, Code, A. S. T. M. Specifications, and the U. S. Steamboat Inspection Service Rules and Regulations.

Allis-Chalmers Tractor Does 35 Miles Per Hour

Fans attending the A.A.A. automobile races at the Wisconsin State Fair Grounds in Milwaukee, June 18, were amazed when an air-tired tractor was run onto the race track. Driven by Frank Brisko, nationally known race driver who was making 118 miles an hour at Indianapolis this year when forced out, the bright orange colored tractor displayed a brand of speed never before associated with the plodding iron horse. An all time world's speed record for tractors of 35.40 miles an hour average for 5 miles was established.

The tractor, one of the new models recently introduced by Allis-Chalmers Mfg. Co. of Milwaukee, with the aid of its Firestone air-tires held the curves on the track like the speedy racing cars. The speed was officially electrically timed by A.A.A. officials.

This remarkable demonstration shows that the tractor has entered a new field of usefulness and that its service is no longer confined to the fields alone, but can be adapted to hauling uses on the highways. In addition to the new tires, the speed record was made possible by the development of a four-speed transmission that gives the Allis-Chalmers tractor the same operating ease as a pleasure car. This is the first time that engineers have been able to adapt the transmission principles of the automobile to the tractor with success, according to the Allis-Chalmers engineers.

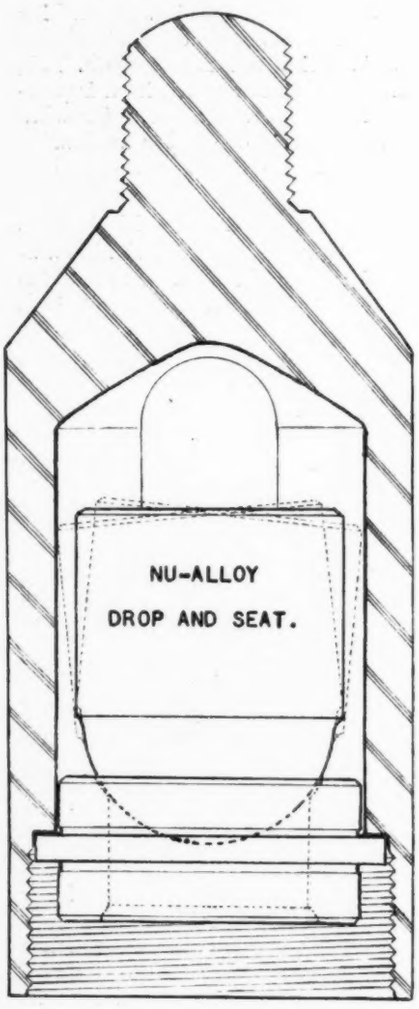
Fred E. Cooper, 211 South Lansing Street, Tulsa, Okla., is oil field representative for Allis-Chalmers winch tractors.

Nu-Alloy Drop and Seat

THE PETROLEUM EQUIPMENT COMPANY, Fort Worth, Texas, has introduced a new ball end drop and seat, made from "Nualloy" non-corrosive steel.

The ball end design of the drop is claimed to stream line the passage of the fluid, instead of creating turbulence, with a flat or open end, under the most severe pumping conditions.

The action of a ball in a valve crown in its opening and closing motion is



to find a bearing, which it does in the form of a spot contact, delivered with considerable impact. In the drop and seat, the drop is perfectly balanced, the side wall contacts the wings of the crown the entire length of the drop, as in a bearing, and the resulting action is a smooth and exact opening and closing movement free from flutter, chatter and pound. The seating is effected by a broad seat which cushions the closing shock. The ball end of the drop is completely protected by the side wall, which projects slightly over the radius of the ball end.

Nualloy drops and seats do not require the use of special crown equipment but will operate in any type standard or A.P.I. crown, according to the manufacturer.

One of the outstanding features claimed for the ball end drop and seat is that it is possible to manufacture equipment to meet any corrosive or abrasive problem found in the pumping of oil.

Axelson Oil Well Pumps

AXELSON MANUFACTURING COMPANY'S Super-Service Liner Insert Pumps are built to deliver efficient production under the most severe conditions that an oil well pump must endure, the manufacturer states. The metal and metal principle characteristic of Axelson pumps is maintained. The hardened liners and hardened ring plungers make possible a pump of unusual durability. For certain conditions it has been found desirable to use instead of the regular plunger assembly, a chromium-plated plunger with rings built up of hard facing steel. The traveling type Super-Service Liner Insert Pump has the barrel assembly with the working valves reciprocating with the rods over the plunger assembly. The use of 12-in. and 24-in. spacers at either or both ends of the pump barrel, makes it possible to obtain correspondingly longer strokes with a given number of liners. The 2-in. Super-Service Liner Insert Pump has a bore of 1¼ in. while the 2 in. size has a 1¾-in. bore. The Axelson Regular Super-Service Liner Insert Pump incorporates the double standing and working valves. As in the traveling type, the valves are spaced closely. A chromium plated plunger with rings of hard facing steel is available for use instead of the steel plunger, if desired.

The Grooved and Seal Insert Pumps based upon the metal and metal principle, offer super-service for average well conditions at an initial cost less than that of the Liner Insert Pumps. A sectional cast iron plunger operates in a seamless steel barrel tube. The reduction of friction through the use of the comparatively loose fitting grooved plunger assembly, is a feature of this type of pump. The turbulence created in each groove causes a sealing affect thus maintaining effective production.

Axelson Star and Star Junior Insert Pumps are similar in construction to the Grooved Seal Insert Pumps. Installation and removal are made with the rods, the pump staying in the old barrel in the well. These pumps are principally for wells where the production has become too limited to warrant the further use of regular pumps run on the tubing.

Oilwell Pumping Equipment

THE NEW "OILWELL" ODH-18 Individual Pumping Power is a structural-steel unit of similar construction to the TC-20 but with a single pitman and a single-crank speed reducer. It is a sturdy and dependable unit that will pump individual wells in the East Texas field efficiently and economically.

The oilbath, roller bearing equipped, Westinghouse-Nuttall ODH-18 double-reduction gear unit is equipped with silent helical gears, a quick-acting brake on the high-speed shaft extension and a crank with five wrist pin holes for the following polished rod strokes: 22½ in., 30 in., 37½ in., 45 in. and 52½ inches. The base of the reduction gear unit is very wide for rigid mounting on the structural-steel base of the power.

The counterweights are of the plate type and are cast to slide conveniently over the extended end of the walking beam where they are securely bolted in place.

The recommended horsepower input capacity of the ODH-18 unit is 20 with an electric motor or 25 with a gas, gasoline or oil engine. An electric motor can be conveniently mounted on a plate provided on the base of the power for that purpose. The recommended maximum pumping speed is 22 s.p.m. and the recommended maximum polished rod load is 14,000 lb. A.P.I. specifications.

The new "Oilwell" No. 80 and No. 150 Belt Tighteners are especially suited for oilbath geared power installations in the East Texas field. Both sizes are Timken bearing equipped and are furnished with easily adjusted, flat-faced pulleys that ride on top of V-belt drives. These belt tighteners are sturdy, dependable, inexpensive and have several outstanding features that are described in "Oilwell" leaflet No. 7.

A new line of Safety Drop-Forged Combination Clamps for ¾-in., ⅞-in., 1-in. and 1⅛-in. A.P.I. Pull-Rods has recently been developed by "Oilwell" for service with heavy-duty central powers. The pull-rod head and upset ends of the loop are completely hooded in each of these drop-forged clamps. These clamps are stronger and safer than other types of combination clamps, according to the manufacturers, and are economically priced. Leaflet No. 8 describing the 1-in. size will be furnished on request to the nearest "Oilwell" representative.

B-M-W Junior Insert Pump

THE BRADFORD MOTOR WORKS, Bradford, Pa., offer in the B-M-W Junior Insert Pump a unit having a small capacity working barrel, possessing all the features of earlier types and, according to the manufacturer, more rugged, assuring longer runs before replacements are necessary. It combines the plunger principle with that of the common working valve. The cups are 1⅛ in., and the plunger 1 inch. The smaller capacity may be obtained simply by removing the cups. When cups are worn the pump continues to function until the stuffing box packing is gone.

This pump is inserted within the standard working barrel. Sand is prevented from settling around the pump by two seating rings located immediately below the stuffing box. The lower valve is also provided with two seating cups, insuring rigidity and perfect alignment.

Lengths are designated by length of working barrel in which the pump is used—for example, the 6-in. pump has a tube 4 ft., 7 in. long and is the correct length for use in a 6-in. stainless steel working barrel. An adapter can be furnished if it is desired to seat the lower valve in the top of the working barrel or in a short special seat.

The outside tube has more than ordinary wall thickness, the size being 1¼ in. O.D. by 1⅛ in. I.D. The plunger tube is of alloy steel, ground and polished. Triad cups are standard equipment.

Compensated Combustion System

THE NEILAN COMPANY, LTD., (division of Mason Regulator Co.), manufacturers of automatic control and regulating equipment, announces a newly perfected compensated combustion control system. The Neilan Combustion Control System consists of two parts, the upper instrument is a compensated boiler pressure controller while the lower and larger is the compensated draft controller. The system is suitable for oil fired, stoker fired or pulverized coal installations. The Neilan control system functions so as to render boiler control entirely automatic. It controls the supply of fuel, regulates the speed and position of dampers or blowers or combinations of the two, so as to insure perfect combustion at all times.

The Neilan system is furnished on a suitable attractive panel board with a special manual control feature which permits either of the two instruments to be thrown out at will and the boiler controlled manually. Advantages from the new Neilan system are worthwhile savings in fuel and the elimination of smoke, according to the manufacturer. The system utilizes compressed air as an operating medium and for this reason the panel board may be removed from the boiler room to a centralized control room when desired. Complete details on the new Neilan Compensated Combustion Control System may be obtained by writing to the Mason Regulator Company, 1190 Adams Street, Boston, Mass., or the Neilan Company, Ltd., at 641 Santa Fe Avenue, Los Angeles, California.

Friendships Old and New

▼

1st NATIONAL

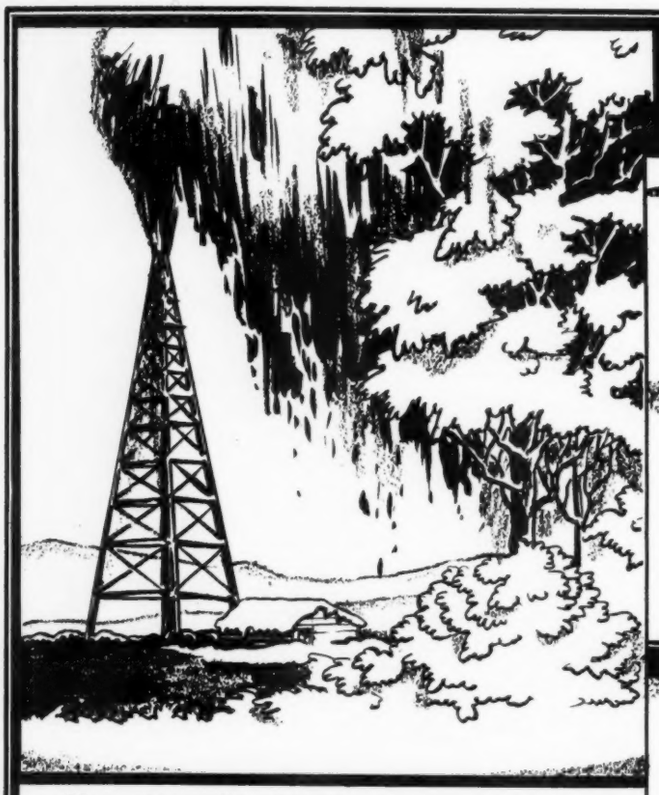
The history of this bank is closely linked with the history of many of the leading industries and business houses of the Southwest. It has served many of these during their entire business life.

Today the First National is making new friends as well as holding its old ones. For families, individuals and corporations like the warm and earnest spirit, the friendly helpful service they find here.

FIRST NATIONAL BANK in DALLAS

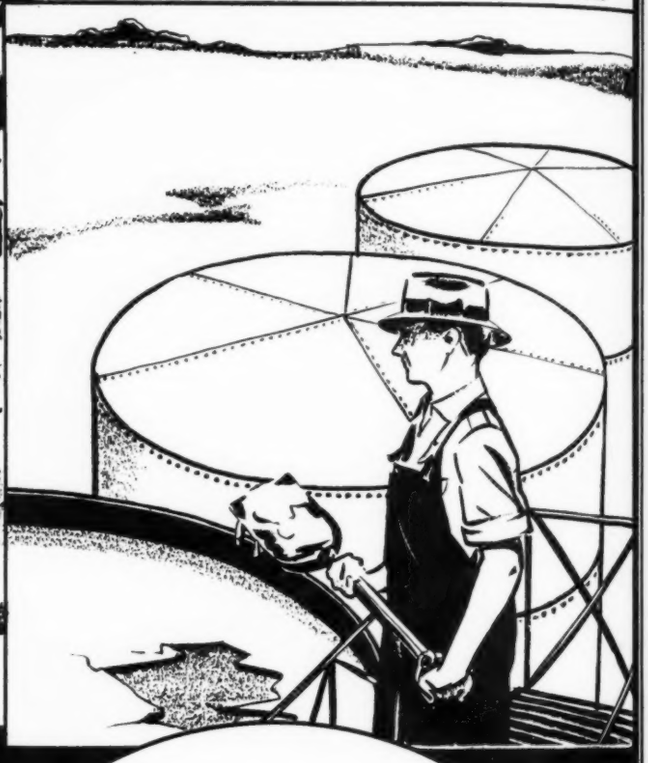
STRANGE.... *but* TRUE

HAPPENINGS IN THE PETROLEUM INDUSTRY



Oil spray from a wild well in Roumania subsequently formed a protective coating of paraffin wax on the foliage of a forest of trees and gave rise to the odd spectacle of the trees retaining their foliage and remaining green throughout one winter.

A well in Hughes County, Oklahoma, has produced in ten years more than 150,000 bbl. of almost pure vaseline, which has always brought a premium of more than 50 cents per barrel. When exposed to the atmosphere the crude product, which tests 48 gravity and 74 per cent of lubricants, congeals rapidly and when stored in tanks a layer of wax that can be scooped up with a shovel forms on the surface.



It is estimated that there are more than 350,000 service stations supplying fuel and lubricants for the Nation's 26,500,000 motor vehicles, or one station to every 75 cars.

In the State of Texas ouster suit against a group of oil companies and the American Petroleum Institute, W. R. Boyd, Jr., executive vice-president of the Institute, gave testimony for eight weeks, and the record of his oral evidence comprises 2500 typewritten pages, in addition almost 1000 exhibits were presented.

Bureau of Mines Makes Oklahoma City Field Report

An estimate of the gas reserves of the Oklahoma City field is the substance of a report recently issued by the U. S. Bureau of Mines. All gas-producing horizons in the Pennsylvanian formations in the field have been studied and the gas reserves of each estimated separately. Similarly, estimates have been made of the gas reserves in the pre-Pennsylvanian formations. Utilization of natural gas in the field is discussed at some length and some interesting data on gas-lift operations of a group of the wells in the field are given.

This report was prepared by H. B. Hill and E. L. Rawlins of the U. S. Bureau of Mines in coöperation with the State of Oklahoma and the Oklahoma City Chamber of Commerce. It may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., by writing for Report of Investigations No. 3217.

Zook Re-elected President of Pennsylvania Grade Crude Oil Association

Ralph T. Zook of Sloan & Zook Company, Bradford, Pa., has been re-elected president of the Pennsylvania Grade Crude Oil Association for the ensuing year. The following directors were re-elected: Forest D. Dorn, R. T. Zook, E. C. Emery and Otto Koch of Bradford; S. Messer, E. C. Breene and C. L. Shur of Oil City, Pa.; E. M. Lyons, Philadelphia; H. D. Atha, Logan, Ohio; John A. Beck, Butler, Pa.; J. P. Flynn, Sisterville, W. Va.; J. D. Dinsmoor, St. Marys, W. Va.; D. B. McCalmont, Franklin, Pa.; D. J. Sweeney, Buffalo, N. Y.; John McCoy, Marietta, Ohio; Fayette B. Dow, Washington, D. C.; H. A. Logan and H. R. Lewis of Warren, Pa.; R. T. Eastell, Pittsburgh, and Earle Craig, Freedom, Pa.

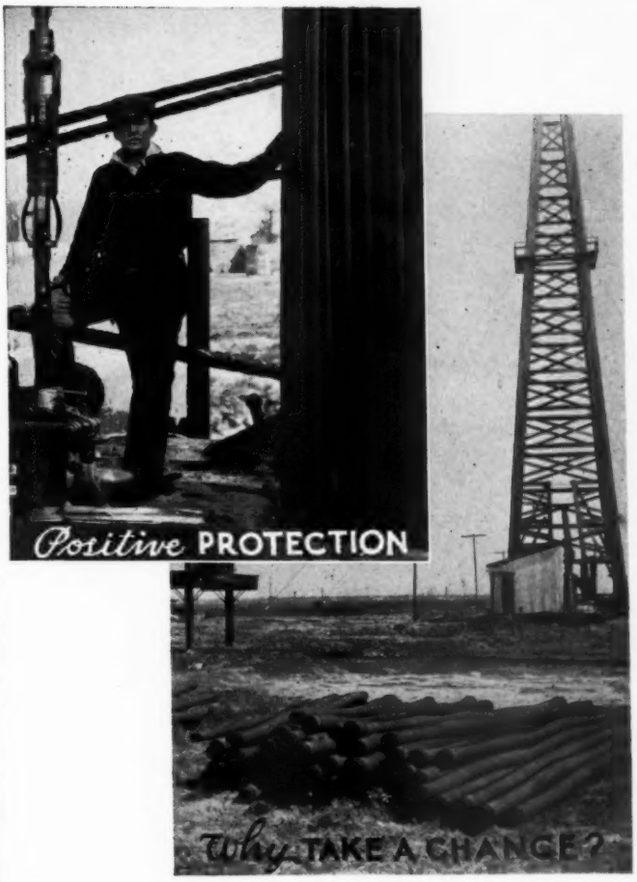
Grease Men Organize

The National Lubricating Grease Manufacturers' Association, Inc., has been formed. The primary purpose of it is to put the grease manufacturing units of the petroleum industry in line for such benefits as may be available to them through President Roosevelt's New Deal. Incidentally, every representative at the organization meeting in Chicago on June 28 expressed a hope that the association would become a permanent organization.

The meeting at the Stevens Hotel was attended by 34 executives of 28 representative grease manufacturers, some major oil companies and some operating exclusively in the lubrication field. They remained in session two days. Their deliberations were harmonious and they accomplished five principal things at five consecutive sessions:

They adopted a tentative constitution and by-laws and they selected officers in conformity with those by-laws. They studied codes written by other groups of oil men and by men of other industries and then wrote and approved a code of their own. They empowered an executive committee of three men to represent them to Col. Hugh S. Johnson and his advisers in the administration of the National Industrial Recovery Act.

Lastly, they provided their treasury with abundant cash to cover incidental, preliminary expenses, looking toward the approval of their code and the formation of a permanent organization. The official personnel of the new organization is as follows: J. R. Battenfeld of the Battenfeld Grease & Oil Corp., Kansas City, Mo., is president of the association; James McKee of Sun Oil Company, Marcus Hook, Pa., is vice president; Guy Peters of Oil Kraft, Inc., Cincinnati, Ohio, is secretary, and H. H. Hower of Enterprise Oil Company, Buffalo, N. Y., is treasurer.



Positive Tubing Protection

The Ever-Ready Tubing Catcher gives you *this* protection. It reduces cost by *eliminating* anchor or excess pipe *below* the perforated pipe. This means less tubing to handle . . . perforated pipe is at the *correct* fluid level . . . no damage or danger should the tubing break. Pressure and fluid will not retard the running of the Ever-Ready Tubing Catcher. For *positive* protection, use the Ever-Ready Protector.

East Texas Service

Call 9064-W-4, Longview

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Separator Corp.

TULSA, OKLAHOMA

Houston Pres. 7710 | Fort Worth Dial 7-3903 | Pampa 390 | Oklahoma City Dial 7-1292 | Seminole 306 | Wichita Dial 4-6094

...IN 24 hours
an AXELSON pump
paid for itself!

In the Mid-Continent a superintendent used an Axelson Pump for the first time in a well making a very small amount of fluid. In less than 24 hours the increased production which the Axelson pump gave had paid for the pump as well as the Axelson stuffing box purchased at the same time.

The reason for an outstanding performance such as this is not hard to find.

Axelson engineers design pumps and sucker rods to meet as closely as possible specific pumping conditions and when correctly installed and operated deliver an unexcelled service.

Axelson Pumps are made in over 50 types and combinations to fit every oil well condition.

Axelson Sucker Rods are made in three kinds . . all built to standard requisites.

AXELSON MANUFACTURING CO.
P. O. Box 710, Vernon Station, Los Angeles, Calif.
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Mid-Continent Representatives:
Frick-Reid Supply Corp.
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Great Northern Tool and Supply Co.

AXELSON PUMPS AND SUCKER RODS

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

He—I know a girl who's never been kissed, so she swears.
She—My gosh! Who wouldn't?—*West Coast Trade.*

* * *

"Can't you come over, Grace? I want to show you my nice pansy bed?"
"Oh, I'd love to. Fancy having a special bed for those saps!"

* * *

Rastus and Liza were married but a short time when he came home with a big washtub, a washboard and a handsome three-foot mirror.
Liza—Whut's all de truck you brung?
Rastus—Not all, but yo' kin take yo, pick. Yo' kin take de tub an' washboard an' go to work, or yo' kin take de mirror an' set down and watch you'se'f starve.

* * *

He—I want to ask you a riddle. Why is it that you have so many boy friends?
She—I give up. —*Whiz Bang.*

* * *

Encore

Myrtle—I'm nursing now at the Old Musicians' Home.
Gert—Poor old things! I'll bet they're tickled to death with just a kindly smile and loving pat on the head.
Myrtle—Yeah! All except the old fiddlers.

* * *

Once upon a time there was a pretty, modest country girl who went to a wild masquerade party dressed in a costume of corn leaves and was shocked several times before the evening was over.

* * *

"What happened to your good-looking boy friend who had such a cute apartment?"
"Oh, I just decided I couldn't put up with him any longer."

* * *

Gert, the cook at the logging camp, has named her little son Sweden after the land of his fathers.

* * *

She—When I take my vacation I'm going home and spend all my time ice skating, skiing and necking.
He—Where do you live, girlie?
She—Florida. —*The Eye-Opener.*

* * *

First Squaw—The chief is neglecting you a lot, isn't he?
Second Squaw—Yes, I wish I had a buck for every night he's away from home!

* * *

Mother Dog—Daughter, don't you think it's about time we had a little heart to heart talk?
Daughter Dog—Oh, never mind; I've already picked up a few pointers for myself.

* * *

"Thirteen children in ten years! Land Sakes! What were you and your husband thinking about?" —*The Eye-Opener.*

* * *

Minnie Horse—What's the matter with Fanny Filly; the boss isn't going to race her any more this season?
Peggy Pony—Oh, she jumped the fence one night, and now she's got a little charlie horse.

Potential Market for Road Oils Is Enormous

By F. R. STALEY

IN recent years the demand for liquid asphaltic materials that are satisfactory for the construction or the treatment of low-cost roads has constantly increased. Every state in the Union has many thousands of miles of unpaved roads that must be serviceable throughout the year. Investigations conducted by the U. S. Bureau of Public Roads and various state highway departments have showed that excellent, all-weather surfaced roads can be constructed at very low cost by using liquid asphalts of good quality.

Through the coöperation of the U. S. Bureau of Public Roads and the Asphalt Institute, a series of specifications covering 13 grades of liquid asphaltic materials has been proposed and recommended to the Federal Specifications Board. These materials are of three general types, slow-curing, medium-curing, and rapid-curing. One of the slow-curing products, Type SC-1, is recommended for use as a dust layer; one of the medium-curing products, Type MC-1, is recommended for use as a primer; and one of the rapid-curing products, Type RC-1, is intended for use in surface treatments. The other grades of material are designed for use in low-cost road construction. The medium- and the rapid-curing liquid asphalts are cut-back products that are manufactured of refined asphalt cements and volatile solvents. When tested in the laboratory, and also when used in road surfaces, the volatile distillates are given off, leaving residues that have essentially the same physical and chemical characteristics as the base asphalt.

The slow-curing materials are derived from crude petroleums having widely different characteristics. The finished products are the result of different refinery processes. There may be a considerable difference in the service behavior of materials of this class, even though they all comply to the most adequate specifications that can be written at the present time. Work is being done to develop the needed information.

The principal uses of liquid asphaltic road materials is outlined by Prevost Hubbard as follows: (1) Surface Treatment. This includes dust layers or slow-curing products, primers or medium-curing products, and carpet builders or rapid-curing products; (2) Admixtures. Rapid-curing products with coarse open aggregates, and medium- or slow-curing products with dense graded aggregates.

The dust layer is a product of very low viscosity, which is necessary to permit it to coat the very finest mineral particles on the road surface and hold them in place. The product should not cure or harden to any extent after application and the residue from distillation should be quite liquid and the lower the percentage of distillate at 680 deg. fahr. the better.

The primer is a cut-back asphalt of very low viscosity. It is used in the initial treatment of sub-grades and non-bituminous roads such as sand-clay, gravel, etc. This product should develop an asphalt cement after application in the upper portion of the treated surface. The consistency of this cement is immaterial, as it is expected to serve as a waterproofing rather than a bonding medium.

The carpet-coat material is a rapid-curing cut-back asphalt

PROPOSED SPECIFICATION REQUIREMENTS FOR LIQUID ASPHALTIC ROAD MATERIALS*

Test Requirements	Material Type												
	SC-1	SC-2	SC-3	SC-4	MC-1	MC-2	MC-3	MC-4	MC-5	RC-1	RC-2	RC-3	RC-4
Water and sediment, per cent	2.0—	2.0—	2.0—	2.0—									
Flash point, deg. F	150+	200+	200+	250+		150+	150+	150+	150+	80+	80+	80+	80+
Viscosity, Saybolt Furol at 77 deg. F., sec	20–150				40–150								
Viscosity, Saybolt Furol at 122 deg. F., sec		200–320								80–160	200–400		
Viscosity, Saybolt Furol at 140 deg. F., sec			150–300	350–550		150–250	300–500	500–800				275–400	700–1400
Viscosity, Saybolt Furol at 180 deg. F., sec									170–280				
Total distillate to 374 deg. F., per cent by volume										5+			
Total distillate to 437 deg. F., per cent by volume		2—	2—	2—	10—	2—	2—	1—	1—	12+	10+	3+	0.5+
Total distillate to 600 deg. F., per cent by volume		15—	10—	8—	25+	10–20	8–20	16—	14—	25+	20+	14+	7+
Total distillate to 680 deg. F., per cent by volume	50—	25—	20—	18—	50—	27—	25—	25—	20—	40—	35—	30—	25—
Float of residue, 122 deg. F., sec	50—	25+	25+	25+									
Penetration of residue, 100 g., 5-sec., 77 deg. F					70–300	100–300	100–300	100–300	100–300	60–120	60–120	60–120	60–120
Ductility of residue, 77 deg. F., cm					60+	60+	60+	60+	60+	60+	60+	60+	60+
Solubility of residue in carbon disulfide, per cent	99.0+	99.0+	99.0+	99.0+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+
Recommended Uses													
Dust layer	X												
Primer					X								
Surface treatments										X			
Mixed-in-place construction:													
Aggregate, densely graded[1]		X	X[5]			X							
Aggregate, open graded[2]											X	X[5]	
Coarse aggregate[4]												X	
Plant-mixed construction:													
Aggregate, densely graded[1]			X	X			X						
Aggregate, open graded[3]											X	X	
Aggregate, open graded[3]								X	X				
Coarse aggregate[4]												X	X

[1]Maximum size not over 1 in. Fairly uniform grading from coarse to fine with appreciabel percentage passing No. 200 sieve.
[2]Maximum size not over 1½ in. Fairly uniform grading from coarse to fine with little or no material passing No. 200 sieve.
[3]Maximum size not over 1 in. Fairly uniform grading from coarse to fine with little or no material passing No. 200 sieve.
[4]Maximum size not over 1½ in. Little or no material passing ¾ in. screen.
[5]Under favorable conditions only.
*U. S. Bureau of Public Roads.

Leaders and only exclusive rod manufacturers for 40 years.

●

JONES
SUCKER RODS
PULL RODS
POLISHED RODS

Rods to Meet All Conditions

●

Jones' Developments Are Usually Followed

The S.M.JONES CO., Toledo, O.
19 Rector Street, New York City, N. Y.
McBirney Building, Tulsa, Oklahoma

of somewhat higher viscosity than the other surface treatment materials, but sufficiently low to permit it to be applied under pressure with no preheating. Within a short time after application it will develop into an asphalt cement of high bonding strength.

The production of high grade asphalt cements require judgment in the selection of crudes, and care in refining. Slow-curing products are made in some refineries from cracked residues, but the best results can be obtained only by controlling the processes with careful attention to the residual. Many refineries operating cracking units are now studying the possibilities of manufacturing road oil materials.

Emulsified Asphalts. Emulsified asphalts are widely used in road building. The advantages claimed for this material is the elimination of heating kettles, the possibility of application in damp weather, a smaller quantity is required, and operations are not limited to mild weather.

Fain and Hixson divide asphalt emulsions into three types, stable, unstable and intermediate. Stable emulsions are dispersions of asphalt in water that are not broken down by addition of even strong electrolytes or by vigorous mechanical action. They may be mixed with fibers, lime or portland cement. Their dried film does not flow under heat as the cellular honeycomb structure surrounding each asphalt particle remains after coalescence and acts as a barrier to the enclosed asphalt. Mineral powders are largely used as emulsifying agents, bentonite is the material generally employed. Asphalt, heated to a temperature at which it is readily fluid, and a suspension of bentonite in water flow together into mechanical agitators. Asphalt dispersions are prepared by mixing bitumen, aluminum hydroxide paste, clay and water.

Unstable emulsions are made from asphalt and water, using soaps as emulsifying agents. With certain asphalts containing saponifiable constituents, emulsification is accomplished by the use of alkali alone. Composition and concentration of the soap solution must be controlled, and the temperature of mixing must remain within narrow limits. Emulsifying agents used with asphalt are inorganic oxides, colloidal clays, and soaps. By using bentonite a much lighter ratio of asphalt to non-volatile matter was at once obtained. In manufacturing emulsions the suspendability, emulsifying power, viscosity and hydrogen ion concentration of the clay should come within definite limits. The breaking value of the emulsion must suit the requirements of the particular job.

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Prevost Hubbard, "Liquid Asphalt Road Materials," A.P.I., Tulsa, 1933.
E. F. Kelley, "Specifications for Liquefied Asphaltic Materials," A.P.I., Tulsa, 1933.
Universal Oil Products, Bulletin 114.
Fain and Hixson, "Emulsified Asphalt," Chem. & Met. Engineer, April, 1933.

Lufkin Opens Dallas Office

Lufkin Foundry and Machine Company, Lufkin, Texas, has opened an office at 1504 Magnolia Building, Dallas, Texas. The new office is in charge of E. P. Trout, who for the past six years has been in charge of the company's Pacific Coast office, and prior to that time, served in the operating and engineering departments at Lufkin. Mr. Trout has recently spent considerable time in East Texas, thoroughly familiarizing himself with the operating peculiarities of that field.

Manganese Steel Forge Acquires Audubon Wire Cloth Company

The entire business and assets of the Audubon Wire Cloth Company, Inc., wire cloth and wire products manufacturers of Audubon, N. J., have been acquired by the Manganese Steel Forge Company, of Philadelphia, Pa.

The business will be conducted by the Audubon Wire Cloth Corporation, a new organization and wholly owned subsidiary of the Manganese Steel Forge Company. The officers of the new corporation are: L. W. Jones, president; L. W. Jones, Jr., vice president and treasurer; and A. W. Zackey, secretary.

The heavy wire cloth and wire drawing departments of the Manganese Steel Forge Company, now producers of Rol-Man Manganese Steel Screens, will augment the Audubon Wire Cloth Corporation's facilities. A comprehensive plan of modernization and expansion is already under way involving considerable new equipment.

Products of the corporation include a complete range of wire cloth for industrial, mechanical and commercial requirements in steel and all metals; spiral woven conveying belts for process industries; formed and fabricated wire products; trays and baskets.

Jones Opens East Texas Office

The S. M. Jones Company announces the opening of an office at 214 Laird Building, Kilgore, Texas, to facilitate the handling of East Texas business.

L. J. Pundt, Gulf Coast factory representative, and J. G. Litherland, Louisiana and Arkansas factory representative, are combining their time in East Texas and may be reached at the above office.

The S. M. Jones Company through its wide representation and large stocks carried by the various supply companies is in an excellent position to take care of the demand for Jones sucker, pull and polished rods in this area.

Stocks of Jones products are carried by The Atlas Supply Company, The Bridgeport Machine Company, Houston Oil Field Materials Company, International Supply Company, Jarecki Manufacturing Company, Republic Supply Company, Norvell-Wilder Supply Company, Pelican Well Tool & Supply Company and Producers Supply & Tool Company.

There are 15 well distributed stocks of Jones rods available to the producers in East Texas.

NU-ALLOY
DROPS & SEATS
outwear from three to ten sets of Balls and Seats, and will operate in any standard or A.P.I. crown

PETROLEUM EQUIPMENT CO.
NU-ALLOY BALLS & SEATS
FORT WORTH, TEXAS

AMERICAN STEEL SHEETS
FOR ALL KNOWN USES

KEYSTONE COPPER STEEL
AMERICAN SHEET AND TIN PLATE COMPANY PITTSBURGH

In the Petroleum Field

For tanks, drums, roofing and siding of shops, sheds, boiler and belt houses, and general sheet metal work, Keystone Copper Steel *gives maximum rust resistance.*

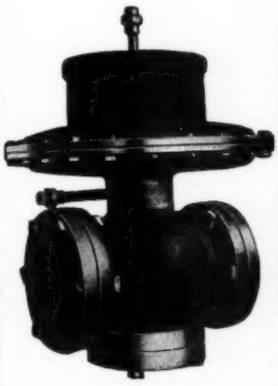
Insist upon AMERICAN Black Sheets, Keystone Rust Resisting Copper Steel Sheets, Apollo Best Bloom Galvanized Sheets, Galvannealed Sheets, Heavy-Coated Galvanized Sheets, Formed Roofing and Siding Products, Tin Plates, Terne Plates, Black Plate, Etc.

Write us relative to your sheet steel requirements. This Company also manufactures U S S STAINLESS and Heat Resisting Steel Sheets and Light Plates for all purposes.

AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh, Pa.

SUBSIDIARY of UNITED STATES STEEL CORPORATION

UNIFORM PRESSURE
at 2 to 6 ounces



EITHER natural or manufactured gas at any medium pressure up to 15 lbs. can be reduced to a perfectly uniform delivery pressure anywhere between 2 and 6 ounces as desired, by use of the Fulton Dead-Weight Regulator. Such delivery pressure will be maintained without variation throughout the whole range of flow. Due to the absence of stuffing boxes, this regulator is highly sensitive and may be used either as a district governor or for individual service. Sizes 3 inches and over have flanged connections and companion flanges bolted on—smaller sizes, screw connections.

C-F

For relieving very low line pressures, not in excess of 6 ounces, the Fulton Dead-Weight Relief Valve is recommended.

There are C-F Regulators for every requirement of pressure control. Used with success over 40 years. Correspondence invited.

The Chaplin-Fulton Mfg. Company
28-40 Penn Avenue Pittsburgh, Pa.

FULTON . . . . . .
DEAD-WEIGHT REGULATOR

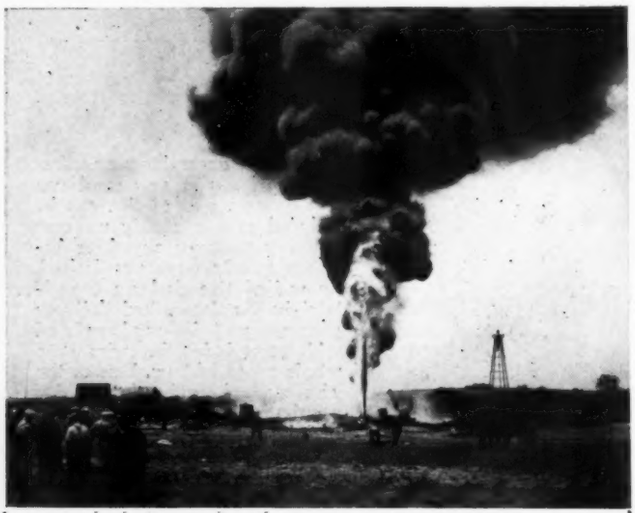
BM PRODUCTS for pumping wells
The KEY to LOWER LIFTING COSTS
CORRECTLY DESIGNED · · ECONOMICALLY PRODUCED
REASONABLY PRICED

No fishing jobs!
Fewer cup failures!

The Security Working Valve provides no opportunity for Bottoms to unscrew, causing fishing jobs. Cups are assembled from the top and LOCKED in position at the correct tension—the fabric of the cups is not cut by the Rings and maximum service is assured.

Security Working Valve

BRADFORD MOTOR WORKS INC.
OIL WELL SUPPLIES
BRADFORD, PA. TULSA, OKLA.
EXPORT OFFICE—30 CHURCH ST.—NEW YORK CITY



Let EXPERIECE Extinguish Your OIL AND GAS FIRES

The M. M. Kinley Company gives you a background of world experience in conquering gas and oil fires. No fire presents conditions unknown to this seasoned organization. The company never has had a failure.

To you, as the victim of a persistent fire, this company offers a saving in time, gas, oil, and finally, MONEY.

M. M. KINLEY COMPANY
TULSA, OKLAHOMA
Specializing in Capping Wild Wells
Extinguishing Well Fires

Cavins Company in New Quarters

The Cavins Bailer Service has moved into its new location at 2853 Cherry Ave., Long Beach, Calif., where a new and modern servicing plant has been built especially for testing and handling of their special clean-out device, known as the Cavins Hydraulic-suction Bailer.

Hereafter the tool will be known merely as a "Cavins" as the word bailer does not properly describe this tool, which is a combination of a bailer, a fishing tool and a perforation cleaner in one tool.

A new name, The Cavins Company, has been adopted for the parent organization, which operates throughout the United States.

Gasoline Plant to Be Built in Moore County, Texas

The first major natural gasoline plant construction program since the Texas law permitting producers in the Panhandle field to use their gas for purposes other than fuel or light became effective is reported.

The Shamrock Oil and Gas Company, which has developed considerable reserve in Moore County, plans to build a 60,000,000 cu. ft. capacity plant. The contract for construction has been let to Sterns & Rogers of Denver, Colorado. The company is also understood to be considering the enlargement of its plant in Gray to 40,000,000 cu. ft. capacity per day. At present the plant has a capacity of 10,000,000 cu. ft. daily.

Oil and Petroleum Year Book, 1933

The 1933 issue of the *Oil and Petroleum Year Book*, compiled by Walter E. Skinner (which has been published annually for the last 24 years) has just been issued.

A number of additional foreign companies have been included in the book, many of which have connections with Great Britain, thus further establishing the book as the Standard International Reference Work. The information, officially verified, deals exhaustively with the operations of the numerous companies and is thus invaluable.

Covering 446 pages, the book contains particulars of 671 English and foreign companies—producers, refiners, dealers, transporters and oil finance companies, including the principal American and foreign companies. Lists are also given of the officials connected with the companies and comprise 2516 directors, 339 secretaries and 183 consulting engineers, managers, agents, etc., their names and addresses and their company connections.

The particulars of each company include the directors, and other officials, date established, location of property, purchase consideration, number of wells drilled, oil production and description of work in progress, capacity of refineries, capital, dividends and financial position as disclosed by latest accounts, also the highest and the lowest prices of the shares for the last three years and the latest price.

Other useful features of the book are the statistical tables showing the world's total production of crude petroleum for the nine years ended December, 1932, the monthly production for 13 months ended April 30, 1933, of the principal British oil companies, list of 539 trade names of petroleum products marketed by the various companies, and a glossary of nearly 500 technical terms and words peculiar to the oil industry.

The book is published by Walter E. Skinner, 15 Dowgate Hill, Cannon Street, London, E. C. 4. Price 7s. 6d. net or post free (abroad) 8s. 6d.

BOOKS *of the* TRADE

DEEP BOREHOLE SURVEYS AND PROBLEMS is the title of a book by M. H. Haddock. The book is an accurate, comprehensive review of the means of obtaining the course of deep bore holes. The author has supplemented his own experience and observations by information from workers in America, Germany, Russia and elsewhere. The price is $4.00.

THE SEVENTH EDITION OF STANDARDS YEAR BOOK (Bureau of Standards' Miscellaneous Publication No. 139) is now available; price $1.00. The volume outlines the activities and accomplishments of federal, state and county agencies in relation to standards, and contains a brief resumé of the standardization work of scientific and technical societies and trade associations.

PETROLEUM PRODUCTION ENGINEERING is the name of the text and reference book on the technology of oil field development and petroleum production by Lester C. Uren. It presents well organized material on developing the field, on drilling methods, on casing methods, on fishing methods, on oil field hydrology and on maximum production methods. It sells for $6.00.

PETROLEUM CODE HANDBOOK FOR 1933, published by Leonard M. Fanning, 258 Fifth Avenue, New York, is available at $5.00 per copy. The volume contains basic statistical tables from Petroleum Facts and Figures, last published by the American Petroleum Institute in 1931. The tables have been brought down to date and include official figures and estimates through 1932. The handbook includes a revised and selected register of over 5000 jobbers, independents, chains, and stations in all states; a gasoline and oil buyers' guide, an equipment buyers' guide, and eight reference sections as follows: petroleum refineries; motor vehicle and gasoline taxes, gasoline bootlegging and tax evasion; gasoline specifications, octane rating, etc.; shipping; fire and accident prevention in marketing; anti-freeze solutions and radiator service; bulk and service station operation; trucks and trailers in marketing.

Trade Literature

Rotating Pumper Company, 1333 Santa Fe Avenue, Los Angeles, Calif., has published a catalog illustrating its oil well pumping units.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., describes the design and construction of Westinghouse heat exchangers in a recent publication.

The Linde Air Products Company, 30 East Forty-second Street, New York, N. Y., has published a 16-page, illustrated bulletin entitled "Oxwelding for General Maintenance."

The Continental Supply Company, 1501 Locust Street, St. Louis, Mo., has issued an illustrated folder on its new champion drop-forged pipe couplings. These were developed to facilitate the laying of pipe lines by the use of straight plain end pipe.

Byron Jackson Company, Berkeley, Calif., has ready for distribution a new booklet on deep well turbine pumps. It is known as Bulletin No. 336 and carries descriptive information on the company's complete line of deep well turbine pumps.

Chain Belt Company, Milwaukee, Wis., has published a pamphlet that is descriptive of its new Rex Deep Well Cabelco Chains for the oil fields.

Kerotest Manufacturing Company of Pittsburgh, Pa., has prepared a bulletin, entitled "Kerotest Cast Steel Throttle Valves," which is available to the trade.

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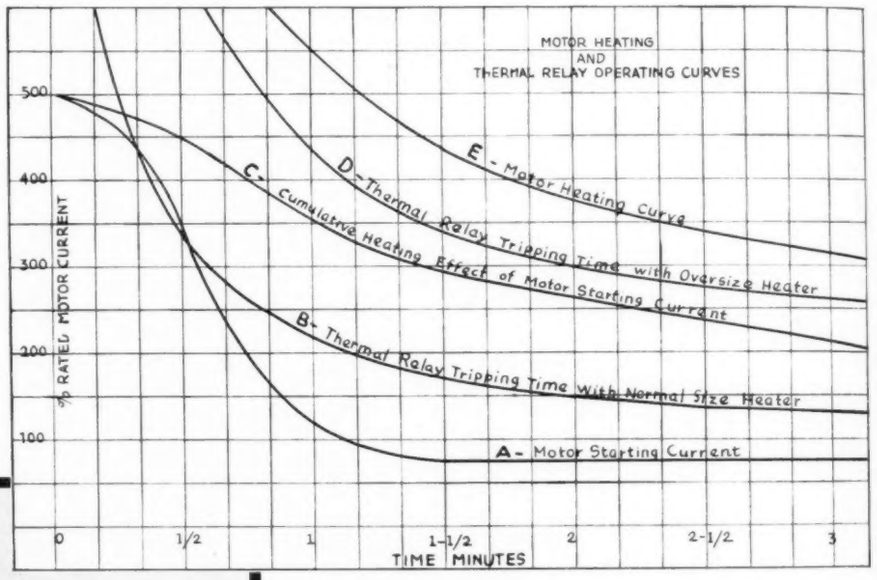
Safeguarding Centrifuge Operation

IN every industry, there are certain machines for which electric drives are most suitable, but which involve periodic or intermittent peak load conditions that make it extremely difficult to provide adequate overload protection for the driving motor. In the refinery, the centrifuge is an outstanding example of this class of machine.

The centrifuge is inherently a machine of high inertia, usually driven by a line-start squirrel-cage motor. When this motor is thrown across the line, it draws a current as indicated by Curve A, Fig. 1. This current varies from approximately five times the motor rated current at the start, down to about 1¼ times rated current at the end of one minute, and finally down to about three-fourths of rated current under steady running conditions.

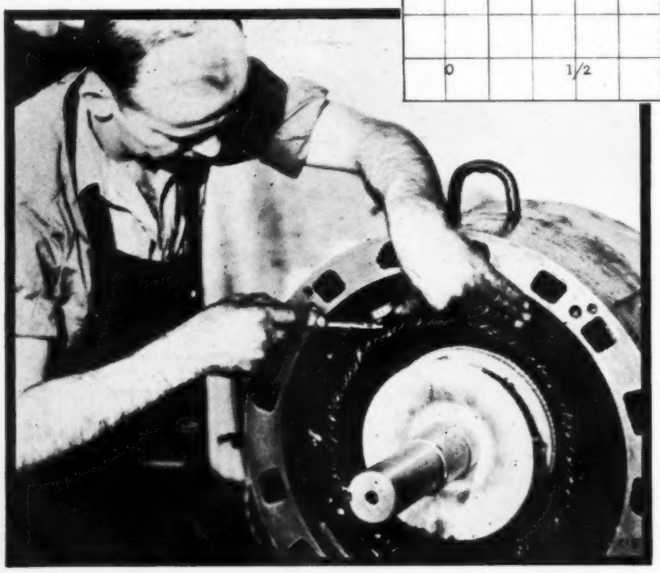
If thermal overload protection of the usual characteristics is applied in the starter, the relay will permit the motor to operate at 115 per cent of full load continuously, and as a protection for running overloads, it will be adequate (See curve B). However, it will be noted that the cumulative heating effect of motor starting current will cause this relay to trip in less than 20 seconds, before the motor has gained any appreciable speed. In other words, a relay that gives normal running overload protection will not permit the motor to reach full speed.

The most obvious solution to this difficulty is the use of a relay of higher current capacity that will permit the motor to start. Unfortunately, a relay that allows a high starting current also allows a high current continuously. In this case, as shown by Curve D, the oversize relay with some margin for unusual conditions, will permit the motor to operate continuously at about 250 per cent of rated load, which means, of course, that the motor has been deprived of overload protection, leaving only stalled-motor and single-phase protection.



Right—Fig. 1, motor heating and thermal relay operating characteristics.

Below—Fig. 3, installing a built-in thermostat on the windings of an enclosed a.-c. motor.



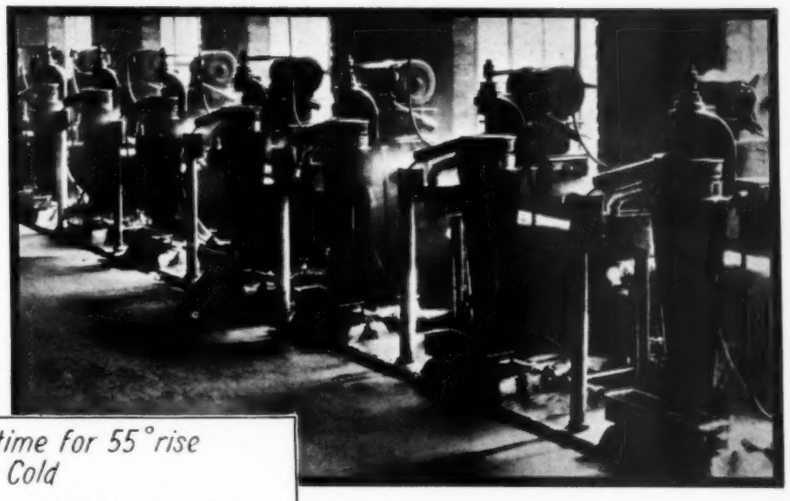
A similar condition results from the use of a dashpot type of magnetic overload relay. A dashpot that will prevent the operation of the tripping mechanism under the starting conditions shown by Curve A, will permit continuous operation of the motor at a load at least as great as that permitted by the oversize thermal relay.

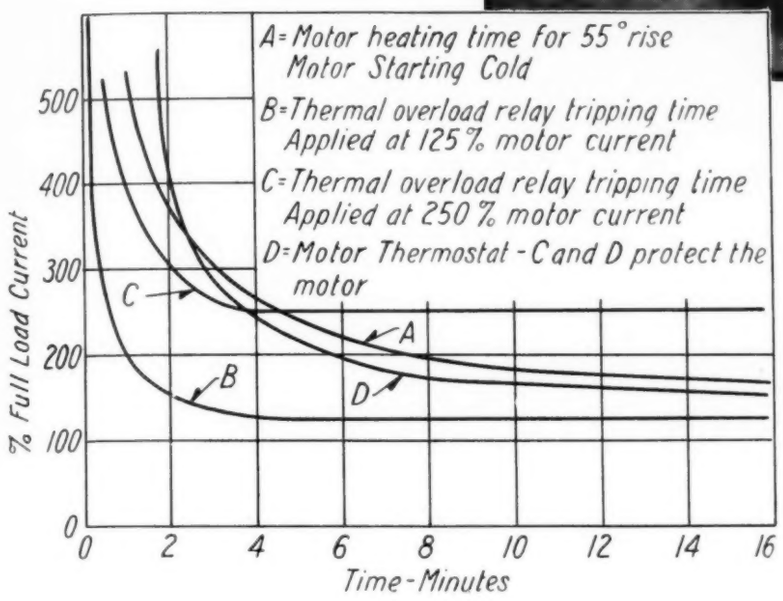
It is quite well known that infrequent heavy overloads, such as are involved in refinery centrifuge service, will not cause excessive temperatures in the motor. This is plainly indicated by Motor Heating Curve "E", which shows that the motor will carry a load greatly in excess of the starting current, Curve A, for a period of time longer

By

D. E. RENSHAW

Industrial Engineer
Westinghouse Electric &
Manufacturing Company





Above—Fig. 2, the motors on oil centrifuges can now be completely protected.

Left— Fig. 4, showing how the thermostat on the motor, plus the usual thermal play, gives complete motor protection.

than that required to start the centrifuge. If the motor is started repeatedly at short intervals, it will undoubtedly reach a damaging temperature, as each successive start will put more heat into the motor than can be dissipated in the short time between starts. Here again, neither a thermal relay nor a magnetic dashpot relay separately mounted from the motor is sensitive to the accumulated heat in the motor, and either would permit repeated starts almost without limit.

Since the ultimate aim of motor overload devices is the protection of the motor from excessive temperature, the ideal protective device is one that is responsive to the actual temperature of the motor windings. Neither the cause nor the type of overload should be reflected at all in the functioning of the protective mechanism. So long as the motor temperature is safely below the point at which insulation is damaged, the motor should be permitted to run, but at the instant the temperature approaches the danger zone, the motor should be shut down.

Frequently, the definition of an ideal is a useless gesture because the attainment is economically impossible. Fortunately, the practical attainment of ideal overload protection has been accomplished. Recent use of a thermostat built into the motor has proved that this device gives protection that is precise, dependable and unaffected by influences other than the motor temperature.

As applied to centrifuge motors, the protective system consists of the thermal relay in the starter and in addition to a built-in thermostat, on the motor. The thermal relay serves to protect the motor when it is stalled or is running on single phase. Under such conditions, the motor is not performing its normal functions and there is no advantage in waiting for the motor temperature to rise before disconnecting the motor from the line. The thermostat on the motor functions when the motor is running to protect the motor windings from excessive temperature, which might result from too frequent starting, increased friction, freezing of oil, stoppage of ventilation, or high room temperature, any of which might cause an increase in the total temperature of the motor.

Where centrifuges are operated in refinery service that requires that centrifuges be started repeatedly at intervals so short that the motor reaches dangerously high temperatures, the advantage of an adequate protective system is obvious. Both the thermal relay in the starter and the built-in thermostat on the motor provide this adequate protective system.

From a wide experience extending over several years, it is concluded that the addition of the built-in thermostat to the protective system will largely eliminate failures in service and will bring important savings in repair expense.

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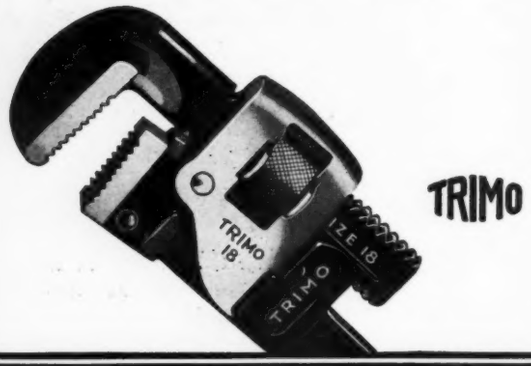

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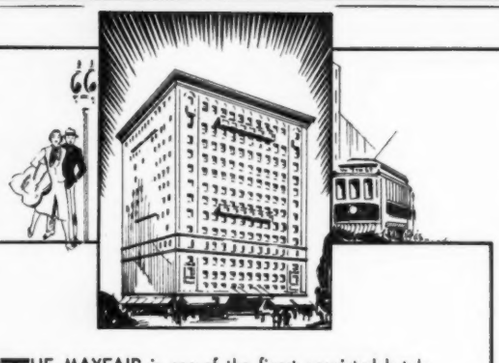

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Oil Industry Has Remarkable Exhibit for 1933 World's Fair

On June 1, 1933, a Century of Progress International Exposition opened in Chicago, and included an elaborate exhibit representing the petroleum industry.

Some 6000 sq. ft. of space in the Hall of Science is allotted to this presentation, which covers the full range of oil company operations as follows: (1) refining, (2) geological-aerial, exploration and mapping, (3) geophysical surveying, (4) deep drilling, sub-surface geology and allied subjects, (5) production, storage and transportation.

The feature of the presentation on geology and production is an oil field diorama 18 ft. wide by 12 ft. high; and 8½ ft. depth of dome. Voice equipment, synchronized with events that occur in this animated diorama, calls attention to important facts in an understandable manner. Every essential of an oil field is being shown, such as storage tanks, derricks, warehouses, slush pits, pipe lines, auxiliary equipment, and other operating machinery.

Oil seepage is illustrated in a smaller diorama. The bubbling gas in the seepage is being animated, and is supplemented by excellent transparencies showing mud volcanoes and additional oil seepages.

A simple, almost symmetrical dome, a subject chosen from a well known Wyoming field, is shown in a three-dimensional model. A cut-out is being shown, illustrating the structural rise of the oil sand and an ideal relationship between oil, gas and water. Glass tubes will indicate wells in this cut-out. Another model shows a splendid example of an asymmetrical anticline. It is so constructed that it may be automatically separated near the center, exposing an excellent cross section of the anticline. There is also a salt dome model typical of the Gulf Coast area. A model of great geological interest is that of the Oklahoma City oil field constructed and loaned by the Sinclair Oil and Refining Company. The complexly faulted and folded structure of the Turner Valley oil and gas field of Alberta, Canada, is the subject of another diorama. It should be of unusual interest as it is one of the most complicated structures known in North America.

A display of rock specimens includes samples of typical reservoir rocks, such as sands and porous limestones; cap rocks, as shale, clays, dense limestone, etc.; mother or source rocks, including dark shales, fossiliferous limestone, diatomaceous beds, etc.

Geological mapping from the surface is being illustrated by a model where surface features are partially covered by glacial drift and alluvium showing what the field geologist must work with in such areas. The glacial drift, etc., is then removed. Lighting effects reveal sub-surface conditions. It is being pointed out how geophysical prospecting and structure core-drilling further augment the surface data. Various charts, maps and transparencies supplement this model. Instruments used for surface geological surveying comprise another exhibit.

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The application of geophysical instruments to the problems of the field geologist is being fully explained. The principles of the Magnetometer, Torsion Balance (gravity), Electrical, and Seismic (artificial earthquake) methods are elucidated by animated models, dioramas, charts and transparencies.

Transparencies show the origin, accumulation and migration of oil in the following series: (a) shore-line lagoons, embayments, delta of rivers where animal and vegetable matter accumulates over millions of years, (b) gradual subsidence of shore-line and ultimate burial by lean material and sands, (c) deep burial of source material, formation of tiny oil globules, gases, and their upward propulsion into "carrier beds"; (d) folding and faulting of sediments, (e) more rapid movement within carrier beds, along faults, etc., into suitable traps.

Dresser Buys Largest Gas Heater Company

S. R. Dresser Manufacturing Company has acquired the facilities and business of the Bryant Heater & Manufacturing Company. The purchase of this Cleveland concern by the world's largest and oldest builder of pipe couplings was consummated on June 15. Operation of both companies is now under Dresser direction. The Dresser chairman, F. A. Miller, and the Dresser president, H. N. Mallon, have taken on like responsibilities in the Bryant Company.

In this latest acquisition by Dresser, gas men see a strong continuation of the Dresser program of expansion that began with the founding of the company at Bradford, Pa., in 1880. Since that time, Dresser has had much to do with the rise of gas transmission and distribution to its present position of importance and modern efficiency. High-pressure gas lines, more than 100,000 miles of them, have been constructed with Dresser couplings; and the company has also developed complete series of clamps, sleeves and fittings that have been widely used for pipe line maintenance. Now, through its ownership of the Bryant Company, Dresser intends to contribute very materially to the building of greater gas loads in this country. Dresser believes that air conditioning, like house heating, calls for the utilization of gas fuel.

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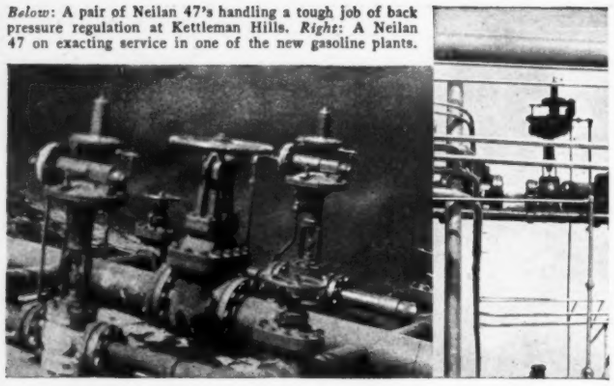
Below: A pair of Neilan 47's handling a tough job of back pressure regulation at Kettleman Hills. *Right*: A Neilan 47 on exacting service in one of the new gasoline plants.



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